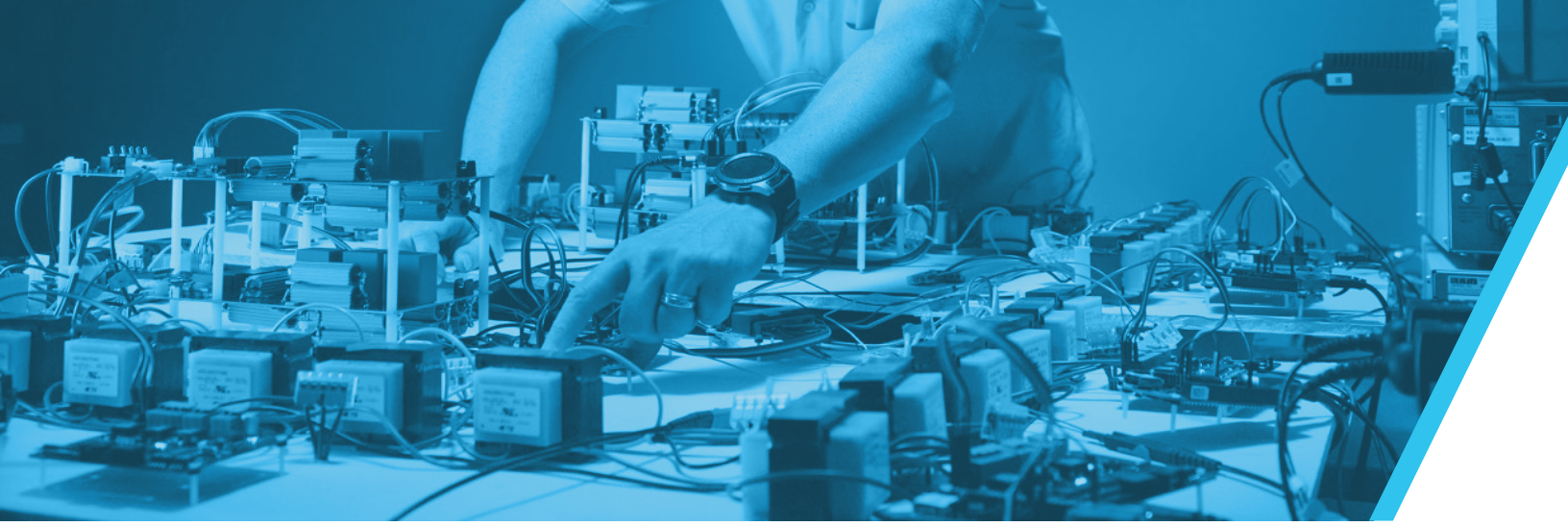


OPAL-RT TECHNOLOGIES

Renewable Power Systems: HIL for Hawaii Island with Siemens

SIEMENS

Application

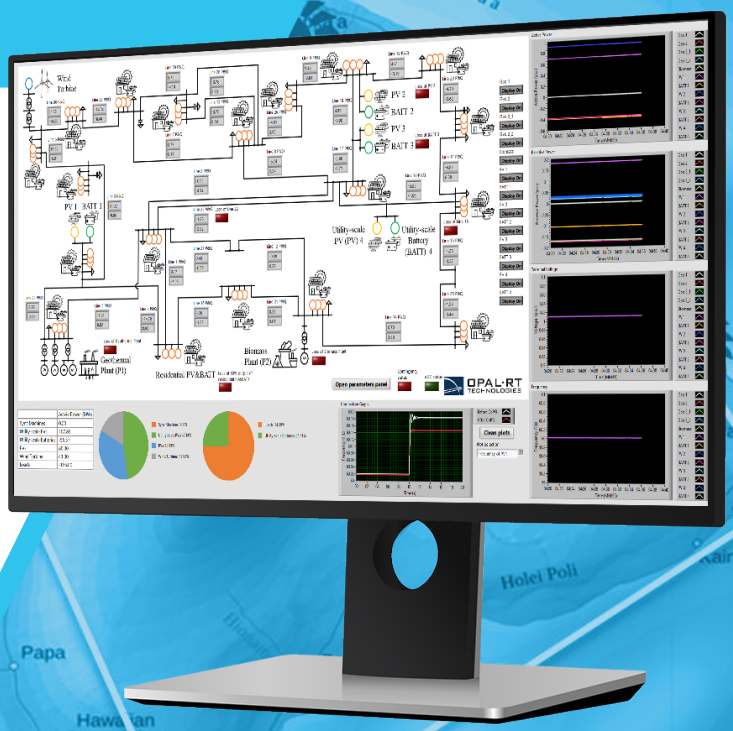
- Renewable Energy

Related Products

- RT-LAB
- ARTEMIS

Type of Simulation

- Hardware-in-the-Loop (HIL)



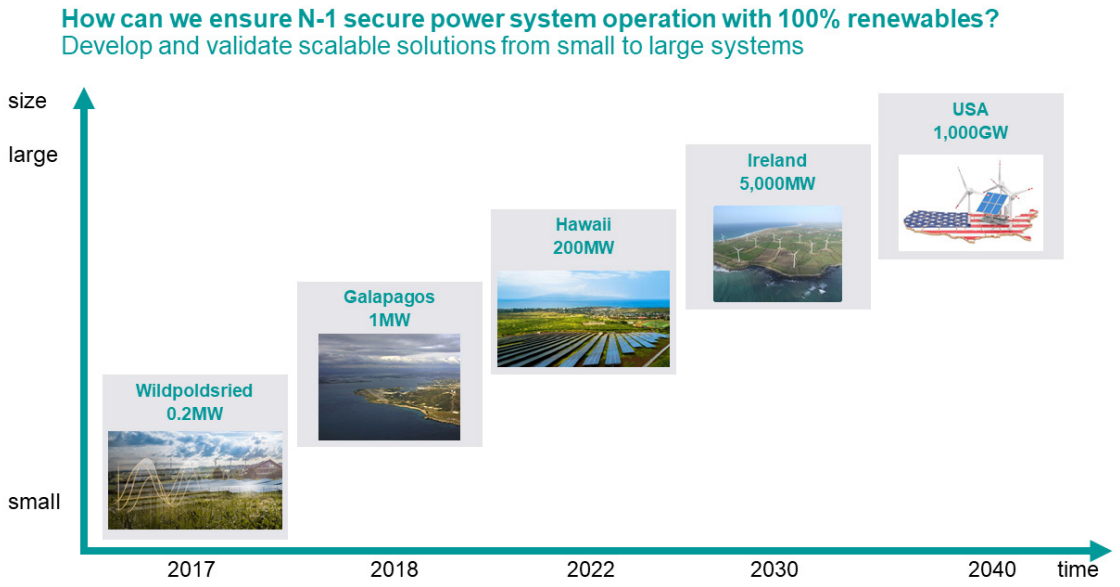
SUCCESS STORY

INTRODUCTION

Siemens is no stranger to impressive and ambitiously exhaustive infrastructure projects, and the one spotlighted in this case study is no different. A research alliance led by Siemens Technology—and supported by OPAL-RT, PNNL (Pacific-Northwestern National Laboratory), and Hawaiian Electric (and funded by the US Department of Energy, ARPA-E)--will evaluate how the largest Hawaiian island may be able to operate reliably with fewer conventional plants to facilitate up to 100 percent renewable energy with the help of an assistant system.

Dr. Ulrich Muenz is Siemens Principal Key Expert Control Systems. Spearheading this effort, it is his responsibility to drive innovation in this project. His specialties as they apply to this project are Automatic Control, Power Systems and Power Electronics: this includes robust and distributed control systems, as well as optimization of intractable—or not readily solvable—issues, and he has had a chance to hone these skills as the control architect for Siemens hybrid power plant in the Galapagos Islands, known for its remoteness.

Islands are very specific cases in this realm—but ideal for testing of autonomy and self-sufficiency--and the figure shows Dr. Muenz's progress in this topic thus far and the future vision to have 100% renewable based grid:

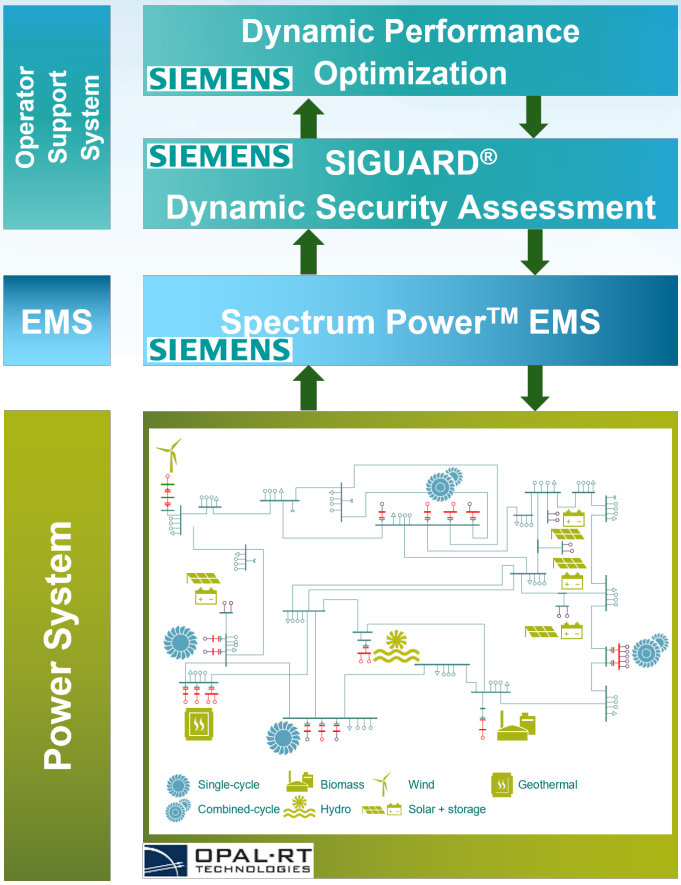


Watch the panel discussion "HIL Simulation and The Future of Grid and Microgrid Controls with Renewables" and learn more about this project.
WATCH NOW >

OBJECTIVE

Hawaii is ready to address its plans to have a 100% renewable energy based grid in place by 2045. The Hawaiian Electric Companies have already established a diverse portfolio of renewables, but Hawaii—as with many other island nations--also relies on conventional power plants to maintain frequency and voltage stability. The goals for a rapid evolution to renewable energy are driven by a desire to reduce the island's dependence on imported oil, in order to reduce fossil emissions and to improve electricity price stability and energy independence.

Microgrid HIL testing is already a challenge but taking it to an actual island makes it even more complex--part of the built-in criteria means that islands themselves are being used by Siemens and Dr. Muenz to test their innovative technologies. Additionally, the N-1 security criterion is a common standard for assessing the security of power systems and indicates that the planned power system should withstand any single component failure without violation in other component constraints while supporting all system loads.



Dynamic Performance Optimization for Harwaii Island's Power System

"We are excited to be the part of this leading-edge project led by Siemens towards achieving the future energy grid with extremely high penetration of renewable energy. Not only we are providing the real-time simulators but also supporting the team in successful implementation of the models and the HIL. Such collaboration between industry experts is invaluable for the success of complex projects like this."

Sudipta Chakraborty, Director - Energy Systems at OPAL-RT

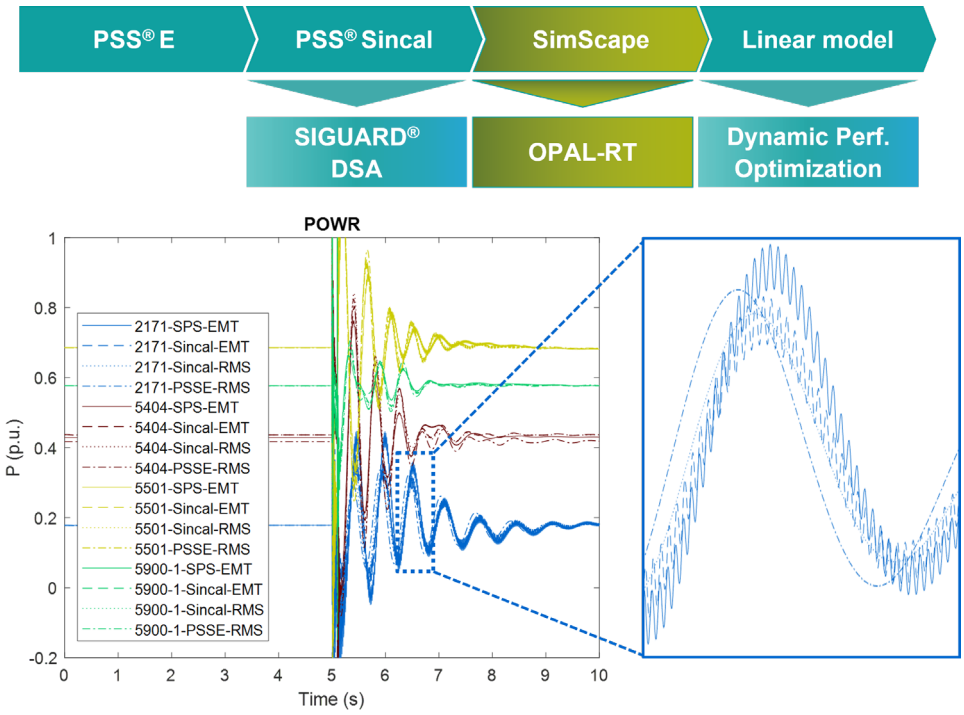
SOLUTION

Energy resources are abundantly available: islands such as Hawaii have enough wind, solar and, potentially, other renewables like hydro, geothermal, or biomass to supply the islands' needs through 100 percent renewable energy. However, the power grid needs to remain stable, reliable and accessible to meet the energy needs of commercial and residential customers. In virtually every place in the world, including Hawaii, the power systems were designed with conventional power plants producing the bulk of the electricity.

Before the real test begins that includes a growing share of renewable energies, the operator support system must prove itself by operating a digital twin of Hawaii's power grid.

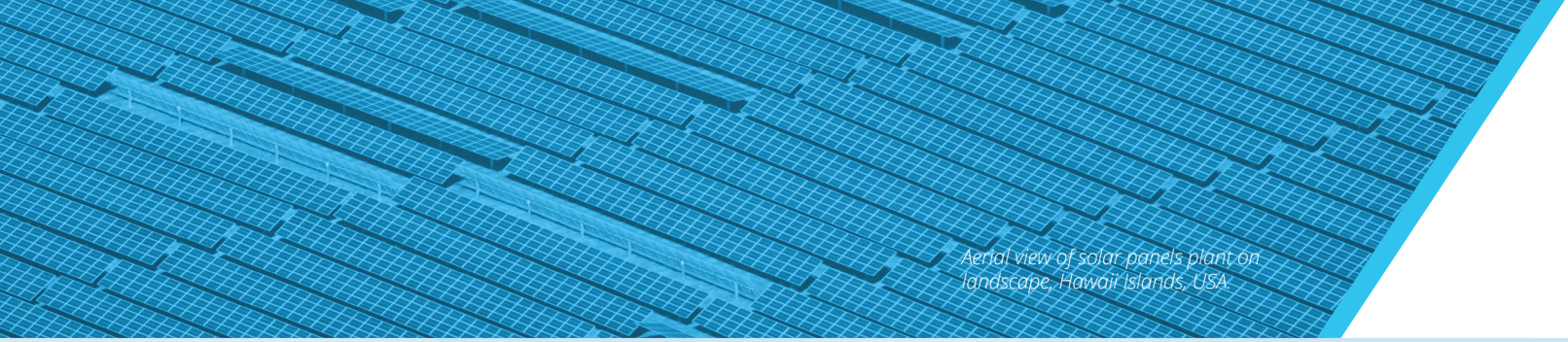
"Such a digital twin is a simulation model showing what will happen in a power grid if we alter key parameters," Muenz said. "We are talking about parameters such as gains of internal control loops of conventional and renewable power plants."

The figure shows the collaboration between Dr. Muenz, the stakeholders, and OPAL-RT in developing a real-time simulation model of Hawaii to demonstrate the operator support program.



The power system model is supplied by Hawaiian Electric in PSS® E, a simulation software for transmission systems. This model is step-by-step converted into high-fidelity, electro-magnetic transient (EMT) models inPSS® SINCAL and Simscape™ which are then implemented into the real-time simulation hardware and software from OPAL-RT.

The real-time simulation of the grid is then connected to the Siemens commercial Energy Management System Spectrum Power™ 7 and SIGUARD® DSA in form of a Hardware-in-the-Loop (HIL) demonstrator system. Using this HIL demonstrator, Siemens is not only validating new operator support systems for the future power system of Hawaii, but they are also creating a platform to show advantages of these new support systems in such high renewable energy scenarios. The demonstrator is hosted in PNNL.



Aerial view of solar panels plant on landscape, Hawaii Islands, USA.

RESULTS

Siemens Energy Management System Spectrum Power™ 7 manages the virtual grid. The assistant system SIGUARD® DSA includes algorithms forecasting how the island grid will respond to critical events. These algorithms provide the grid operator with alternate settings for the inverters of their renewables to reduce power oscillations. The interconnection of the digital twin of the Hawaiian power system in OPAL-RT's real-time simulator with the new Energy Management System enables the team to demonstrate the effectiveness of the new support system under real-world operating conditions.

This provides critical information necessary for the widespread transition to renewable energies and enables stable operation on island grids with high renewable energy penetration on a large scale. As a result, the energy transition can become a reality while the lights stay on in Hawaii.

"Resilient operation of power systems dominated by wind and solar generation is a main roadblock for high renewable integration in systems like Hawaii, Ireland, or Australia. The main challenge is that power system dynamics change fundamentally as the share of renewable generation approaches 100%. The development and validation of innovative solutions for such systems is not possible without a high-fidelity digital twin of the real system. For our project, OPAL-RT was of great support to develop this virtual environment for our demonstrator."

Dr. Ulrich Muenz, Principal Key Expert Control Systems at Siemens

References:
RT21 - HIL Simulation and The Future of Grid and Microgrid Controls with Renewables (https://www.opal-rt.com/resource-center/document/?resource=Mkt_0027376)
ReNew100 – Reliable Power System Operation with 100% Renewable Generation (https://arpa-e.energy.gov/sites/default/files/Siemens%20-%20Ulrich%20Muenz.pdf)
Energy transition, Hawaiian style (https://new.siemens.com/global/en/company/stories/research-technologies/energytransition/energy-transition-hawaii.html)