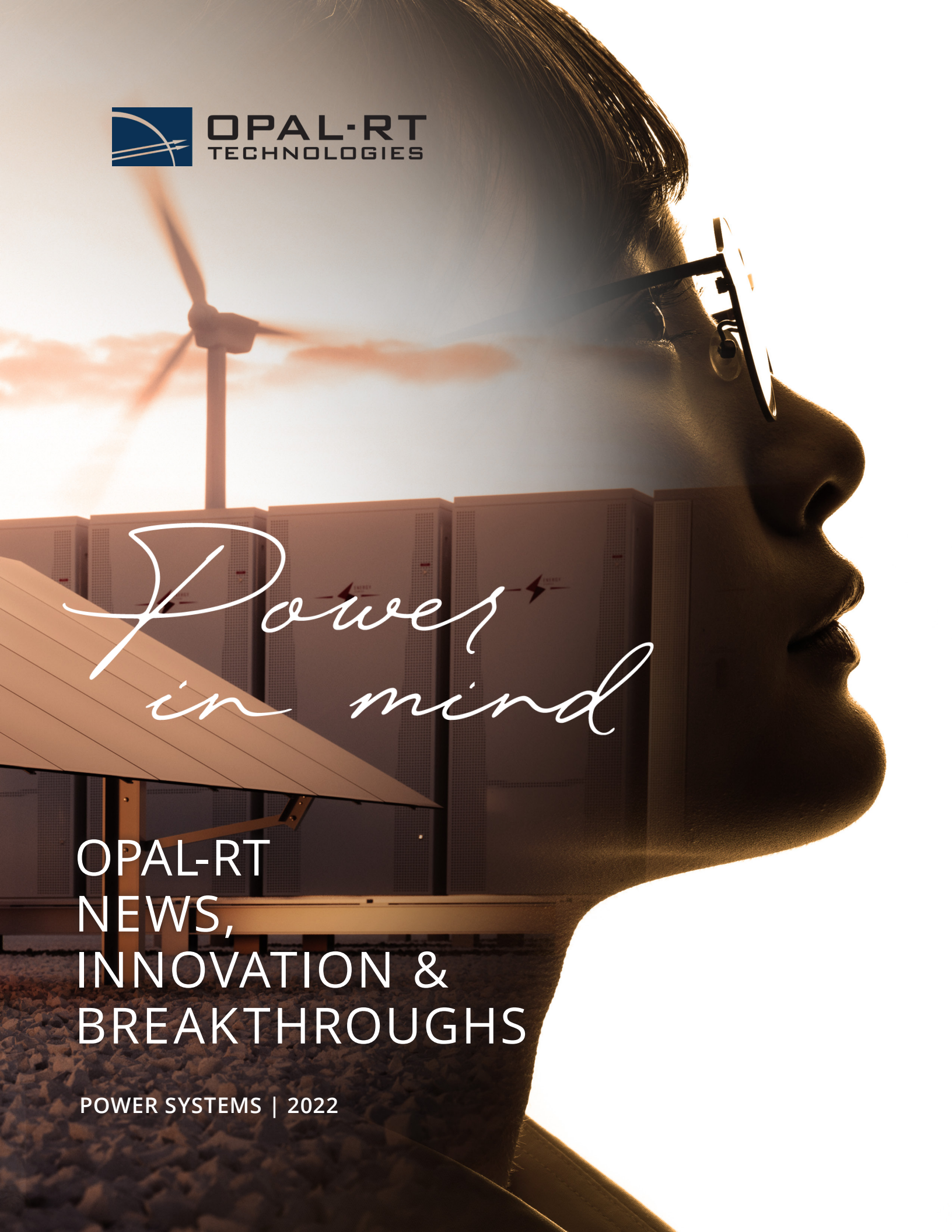


OPAL-RT NEWS, INNOVATION & BREAKTHROUGHS

POWER SYSTEMS | 2022

A Word from the President

Helping the World's Engineers and Researchers Make Innovative Ideas a Reality

Dear customers, partners & friends of OPAL-RT,

My partner and I founded OPAL-RT in 1997, and the company has worked hard to experience continued R&D growth driven by innovation and evolving customer demand steadily in the years since. The company's credo, "to democratize real-time simulation, and to put a simulator on every engineer's desk," is well on its way to being realized, so that—also in line with the company's long-term plan--imagination will finally be the only real limit to complex modern system design.

In celebration of our 25th anniversary in 2022, OPAL-RT finds itself at a promising junction typical of these times, and one that allows us to propel green, energy-saving and future-forward technologies into reality. The company's various platforms have been used recently, for example, in fast-charging EV stations roadside on the Trans-Canada, in test flights of electric commuter aircraft, and they facilitate the use of digital twinning in such contexts as microgrids and hybrid power delivery networks.

OPAL-RT is currently the leading developer of open, real-time simulators, and—for our 25th anniversary--has earned the trust of over 1,500 customers, including Fortune 500 companies, academic institutions, and research labs. The foundation of all the arduous work we have done in the last 25 years emerges from this span of time--and our industry-leading edge, endless curiosity and fruitful partnerships continue. The company, to my immense pleasure, is in the enviable position of having been both a historical pioneer and a futuristic path-builder.

Our innovation roadmap has always inspired us to tread new ground--to work with innovative ideas and their implementation, and to progress consistently further year after year.

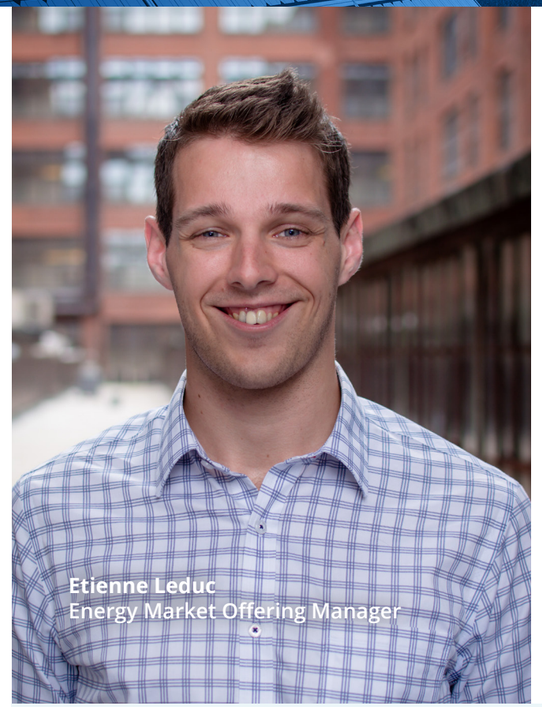
We welcome you to take a look at some of our highlights from past years and explore our ongoing initiatives.

Jean Bélanger, CEO and CTO at OPAL-RT

Jean Bélanger,
Co-Founder, CEO and CTO

Lise Laforce
Co-Founder and Executive Vice-President

Leading the Innovation



Etienne Leduc
Energy Market Offering Manager

Leading the Way in Power Systems Testing

Exciting new technologies are emergent every day, and new challenges continually arise alongside them. Although this publication highlights individual technologies, its aspirational goal lies in examining how we approach innovation and how we take advantage of the opportunities afforded to us. The path to progress does not bravely open to us simply because of a new concept or modern technology. These developments are the sparks that start the fires of progress, but the innovations themselves often require monumental changes in the ways industries are organized and conceptualized. Similarly, the biggest leaps forward often occur because a forward-thinking soul kept asking themselves, "What else might work that hasn't already been tried?"

In the following pages, I challenge you to keep these points in mind. In bringing together our best innovation and the brightest minds in the Power Systems community, our goal isn't simply to show off our latest accomplishments and industry developments, but to foster an environment in which we can learn from each other and grow. I would also invite you to connect with me at etienne.leduc@opal-rt.com to discuss innovative projects such as Vehicle-to-Grid, Hydrogen and 5G, and to discover some of our proposed solutions to the upcoming decade's promising challenges.

Quick Dive into the OPAL-RT Highlights

Digital Twin

System operators worldwide face challenges of daunting and never-before-seen complexity due to the high penetration of renewable energy resources. RMS simulations aren't cutting it anymore and need to be complemented by very fast EMT simulations able to integrate manufacturer real code controller models, to be synchronized with the real-world grid--and to have these stringent demands carried out every 5-10 minutes to test the riskiest of network contingencies. Learn more about Digital Twins on pages 4 and 5.

Product News

OPAL-RT prides itself on flexible, scalable platforms and keeps abreast of evolving industry requirements through intensive and recurring R&D investments. In this issue, see more on eHS' new features on page 6, the latest developments in HYPERISIM on page 9, and learn more about quickly bringing real-time simulated microgrids to the real world with the Microgrid PHIL Test Bench on page 10.

Proud Users

In this issue, we bring to you the Schneider Electric (page 7) and Siemens (page 8) use cases that provide in detail compelling examples of what we make and what we do in dynamic and challenging applications in the real world. On page 11, learn more about how students can broaden and enrich their research by combining Bitlismen's Power Labs Ecosystem with the OP1420 Microgrid PHIL Test Bench.

Solution | **Digital Twins: The Next Decade of Innovation**

High-Speed, High-Fidelity Power Grid Digital Twins: A Control Room Revolution

Imagine having the ability to digitally replicate a Power Grid to its finest detail, then trigger any number of "what-if?" events in any number of locations to see how every component of the grid – from control units to wholesale energy pricing—will react to changing real-world conditions every few minutes? Such insight would prove invaluable and could mean avoiding difficult blackouts, revolutionize operational efficiency, and transform how we think of asset management. At OPAL-RT, we are actively working with world-leading operators to deliver just that.

Today, OPAL-RT is combining the advanced electromagnetic transient simulation platforms boasting sub-50 µs resolution that we have been perfecting for the past 25 years with advanced and secure computer clustering technology to build high-speed, high-fidelity Power Grid Digital Twins. These Digital Twins are highly detailed renderings of nation-scale power systems that also include manufacturer black-box real-code models of Distributed Energy Resources (DER) and their controllers —the most accurate emulations of actual controller DER behavior—to simulate each relevant component of the grid, from individual DER to continent-spanning HVDC lines. Conditions are set according to real-world data and subjected to a great number of real-world scenarios, including changing weather patterns, shifting demand profiles, cyberattacks, faults or potential failures—any "what-if" scenario that can potentially impact the modern grid – with the results fed directly to the operator's SCADA system every 10 minutes. A feat that is made possible through the massive parallelization of hundreds of high-speed processors, running all scenarios simultaneously.

The operational insights gained from these high-speed, high-fidelity Digital Twin simulations include predicting potential failures before they happen, managing the renewables-based energy market in real-time, efficient allocation of maintenance resources, and remotely diagnosing abnormal operations, malfunctions, and problem sources faster.

Simulation has proven to be an invaluable tool for development, design and planning of Power Systems. Now, with our high-speed, high-fidelity Digital Twins, OPAL-RT is helping transform what simulation means in the control room.

An Australian Digital Twin Revolution

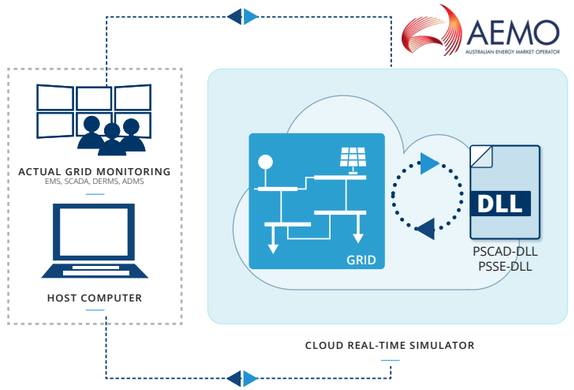
The world's first Power Grid Digital Twin is being built by OPAL-RT with the Australian Energy Market Operator (AEMO). This cloud-based facility hosts the detailed and extensive digital twin of the Australian Grid, run on HYPERSIM, and will initially address urgent operational challenges allowing AEMO to efficiently streamline the connection application process for new renewable generation projects.

AEMO faces distinct challenges with operating a power system that is undergoing a rapid and extensive change from a centralized, conventional generation-based grid to one experiencing exponential increases in solar and wind resource penetration at a continental scale. OPAL-RT's considerable strengths as a solutions provider to address these challenges include, among others

> The ability to host and dynamically update massive clusters of simulations either on a secure in-house server, or off-site in the cloud.

> The capability to accurately execute black box models provided by wind and solar plant manufacturers, even using other simulation tools when required.

> The capacity to run as many parallel "what if" scenarios to completion, every 5 minutes, to give AEMO actionable operational insights.



Learn more on AEMO's project and Digital Twins on the webinar "Cloud-Based Power System Digital Twins". Watch now >

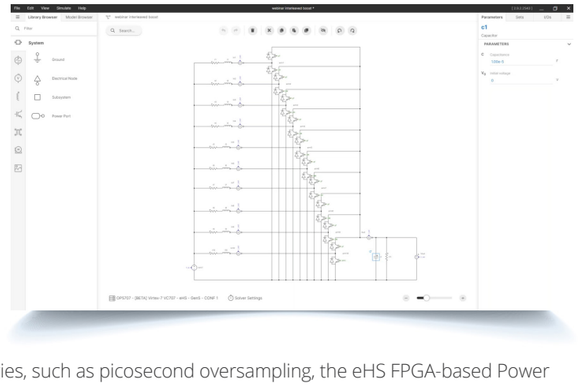
Product News | **eHS FPGA-based Power Electronics Toolbox**

Success story | Schneider Electric

eHS Toolbox: New Features to Get More Done. Faster.

Increasing electrification is putting more demand on power systems, in turn forcing power electronics to evolve to ensure safe and reliable operation. From Modular Multilevel Converters to renewable energy power inverters, the key driver of this evolution are engineers pushing the limits of power electronics in terms of speed and performance by introducing faster, more powerful advanced converter topologies.

RT-LAB HYPERSIM



With the latest developments in solver technologies, such as picosecond oversampling, the eHS FPGA-based Power Electronics Toolbox allows engineers to stay ahead of the curve by offering market-defining speed, accuracy, reliability, and power no matter the circuit or application. With our easy execution, you are only 3 steps from FPGA simulation, no matter the scale of your circuit.

No Decoupling

Run up to 24 converter models (144 switches) on the same FPGA core, removing the instabilities and increased time steps inherent with electric circuit partitioning.

Easy Workflow

Three steps to Real-Time FPGA simulation: 1- Develop the model in the circuit editor; 2- Configure the I/O channels; 3- Execute in Real-Time.

Free up the FPGA

Put the microgrid, PMSM, or any other component that doesn't require FPGA speed on the CPU to enhance both efficiency and performance!

Picosecond Oversampling

Oversampling with interpolating converter models ensures the highest sampling resolution and accuracy available for applications such as on-board charging.

Watch this webinar to see how the eHS FPGA-based Power Electronics Toolbox is redefining speed and accuracy for Real-Time FPGA power electronics simulations.
Watch now >

Schneider Electric's AccuSine: Active Harmonic Filter (AHF)

Challenge

Schneider Electric's AccuSine® PCS products are designed to mitigate harmonics and reduce voltage fluctuations from power electronics. But the AccuSine PCS units can be quite complex and configured with up to 8 units in parallel, which can be a challenge to simulate for some HIL systems without introducing instabilities due to electric circuit partitioning.

Results

John Batch, a Firmware Engineer at Schneider Electric says that the ability of eHS to simulate all eight units in parallel allows them "to simulate customer issues with more accuracy, to test and improve our firmware before we release it, and to start product development before we have hardware for new designs. In general, HIL has been a great asset and timesaver. For example, now when we take a unit to Europe, we have confidence that it is going to work when we get there. When on a customer site, we can focus on testing that's more beneficial than just getting it to work at 50 Hz."

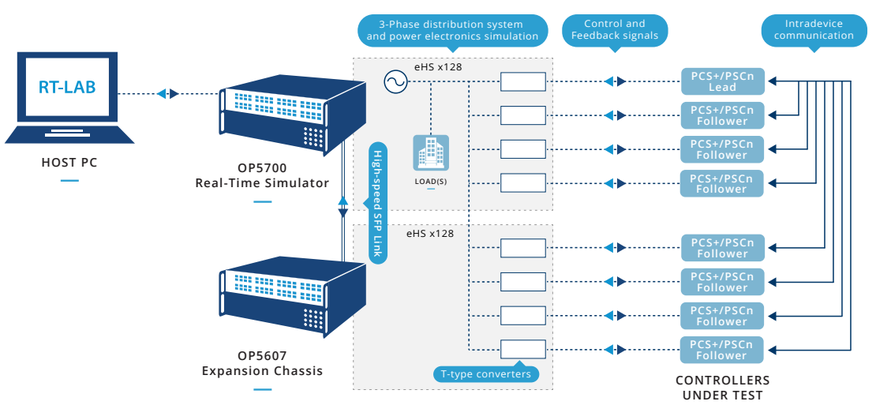
This is saving Schnieder significant resources in development, commissioning, and support while increasing uptime and reducing risk to the clients.

Solution

OPAL-RT's eHS FPGA-based Power Electronics Toolbox responds to this need, allowing the simulation of 8 units with a single decoupling point and no impact to the overall stability and fidelity of the simulation. Using eHS, engineers at Schneider can subject the actual product to a variety of use cases, whether it be 60 or 50 Hz grids, multiple stacked units, different grid impedances, balanced and unbalanced loads – all the situations the AccuSine PCS units will be exposed to in the field – all before leaving the factory floor.

"With HIL, one of the biggest advantages is being able to test the actual product. We can simulate all sorts of use cases: 50 Hz grids, multiple stacked units, different grid impedances, balanced and unbalanced loads-- all kinds of situations." John Batch, Firmware Engineer at Schneider Electric

Read the full success story here >



HIL for Hawaii Island with Siemens

Challenge

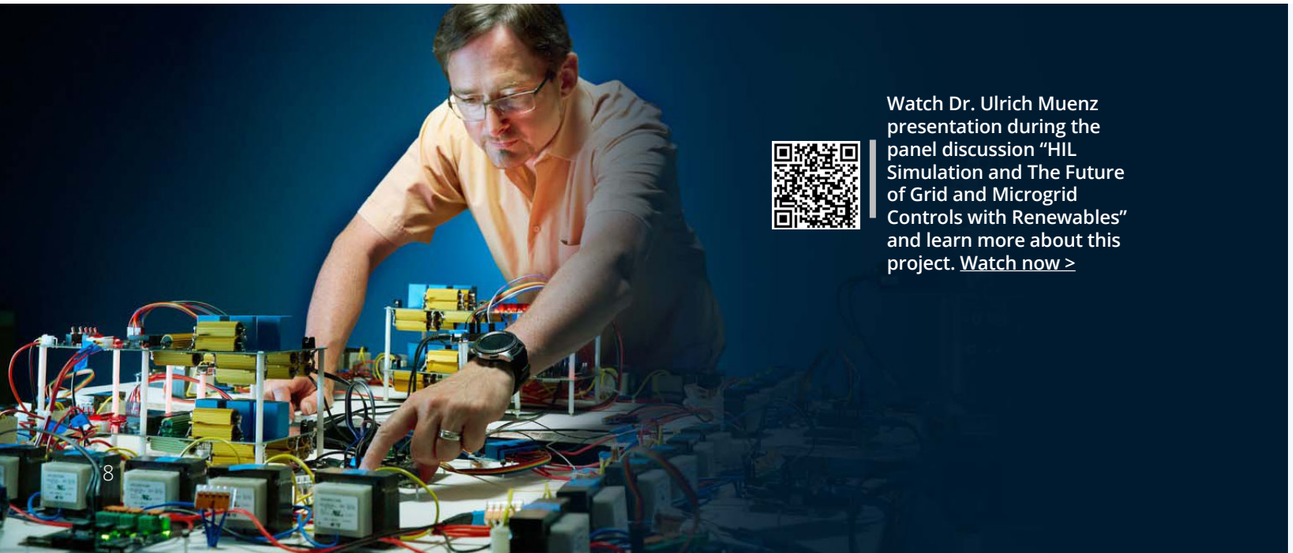
An alliance led by Siemens Technology, supported by the Pacific Northwest National Laboratory (PNNL), Hawaiian Electric, funded by the US Department of Energy, and powered by OPAL-RT is evaluating how operator support systems can ensure an N-1 secure power system operation on Hawaii's Big Island as it transitions to a 100% percent renewable energy grid by 2045. The goal is to meet net-zero targets, reduce dependance on oil imports, and ensure energy security for future generations of Hawaiians without disrupting today's distribution.

Solution

Before going live with a growing share of renewable energies, the operator support system must prove itself by operating a real-time 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," says Dr. Ulrich Muenz of Siemens. The power system model is supplied by Hawaiian Electric in PSS®E, a phasor-domain simulation software for transmission systems. This model is converted into high-fidelity, electro-magnetic transient (EMT) models executed by the Real-Time simulation platform from OPAL-RT forming the Digital Twin. This Digital Twin is then connected to the Siemens Energy Management System in a Hardware-in-the-Loop (HIL) system hosted at PNNL.

Results

Interconnecting the Hawaiian Grid real-time Digital Twin to Siemens' Energy Management System exposes the operator support systems to real-world conditions in a risk-free environment. These operator support systems provide Hawaiian Electric with alternate settings for the inverters of their renewables to reduce power oscillations and allow them to verify and understand the management of the future grid as well as forecasting how the grid will respond to critical events. All while using their own real-world Energy Management System. This provides essential information for the transition to renewable energies, gives the operator valuable training opportunities, and enables stable operation on the island grid 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.



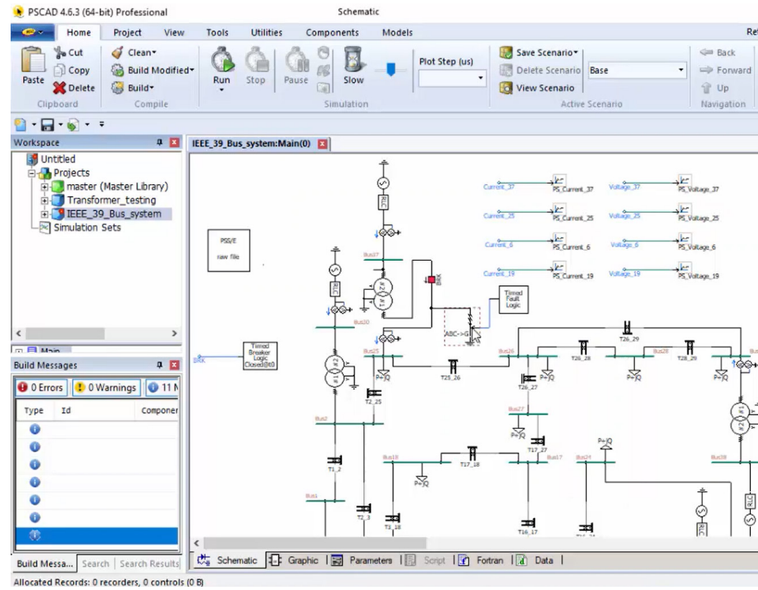
Watch Dr. Ulrich Muenz presentation during the panel discussion "HIL Simulation and The Future of Grid and Microgrid Controls with Renewables" and learn more about this project. Watch now >

High-fidelity Power Grid simulation, no matter the design tool, domain, or size

HYPERSIM provides advanced compatibility tools enabling unparalleled high-fidelity power grid simulation at Real-Time or in Accelerated Mode!

The grid can be complex enough, so why create barriers to accurate real-time simulation? Whether it's because you've started with an off-line simulation tool, or you need a detailed co-simulation of a DDoS cyberattack or can only access black-box models from a wind farm manufacturer, HYPERSIM provides the tools for you to execute in Real-Time without re-inventing the turbine.

Watch this webinar to see the import workflow, multi-domain and multi-target co-simulation in detail Watch now >



Import from the most advanced tools

HYPERSIM's import and compatibility tools let you flow from offline to Real-Time in no time. With precise parameters mapping and intelligent integration, you can confidently import and simulate models developed in **PSCAD, PSS®E, EMTP, Simulink®,** and even black-boxed manufacturer real code as of DLLs and LIBs.

Multiple Domains, One Result

Out-of-the-box Multidomain co-simulation via toolboxes or integration with HYPERSIM means you can simulate the modern grid as it really is – a complex network of multiple technologies and systems from cybersecurity to power-electronics to alternative power sources – all with their own unique simulation requirements.

Go big with Multi-Target Simulations

With Multi-Target simulation capabilities, HYPERSIM can easily distribute manufacturer black-boxes, or coordinate co-simulated tools across multiple simulators with no instabilities while maintaining high fidelity, accuracy, and precision.

Product News | **Microgrid PHIL Test Bench (OP1420)**

Real Power to Test Microgrid Applications

Quickly bring real-time simulated microgrids to the real world and extend their power busses into the lab to connect and test real power devices with Power Hardware in the Loop (PHIL). Don't know where to start? No problem. Each OP140 Real-Time Microgrid PHIL Test Bench comes with a validated generic microgrid model, detailed DER models and a generic microgrid controller, readily configured for PHIL emulation.

Trustworthy
Made to ensure closed-loop stability, accuracy and high bandwidth PHIL.

Turnkey
Save time and money with an intuitive, ready-to-use solution.

Safe
Turnkey PHIL systems designed with user safety in mind.

SOFTWARE

Compatible with RT-LAB (Simulink® based) and HYPERSIM software platforms, users are able to bring complex microgrid models to life in their lab in a few easy steps.

REAL-TIME SIMULATOR

The OP1420 operates with a Real-Time Simulator featuring a generic microgrid model to help users get started as quickly as possible. Simulators contain multiple processors and a powerful FPGA capable of digitally simulating complex microgrids and power converter systems.

MICROGRID BUS BAR & POWER METER PANEL

Safely interface various equipment to a PHIL node. It supports three-phase interfacing via laboratory 4 mm banana plugs/sockets. In addition, it comes with an accurate power meter panel with integrated on-board LCD display that gives users a realtime visual of the electric quantities of the busbar branches.

PHIL 4Q POWER AMPLIFIER

It includes up to 3 three-phase, high-frequency amplification units of the 4Q power amplifiers designed for PHIL applications involving grid, energy source and/or DER emulation. The Power Amplifiers connect directly to the Real-Time Simulator via optical link for low latency operation.

Watch the OP1420 - Microgrid PHIL Testbench demonstration. Watch now >

Partner Highlight | bitlismen™

Accelerating Academic Teaching and Research with OPAL-RT Microgrid PHIL Test Bench and Bitlismen's Power Labs Ecosystem Trainers

PHIL technology provides invaluable opportunities in academic settings – that's why Universities around the world are rapidly adopting the OP1420 Real-Time Microgrid PHIL Test Bench in their research labs and teaching facilities. But to really take advantage of PHIL requires compatibility and inter-operability with technologies that fully enrich the educational experience with renewables and the evolving grid.

That is why we are very proud to announce that OPAL-RT has joined forces with Bitlismen to deliver a combined total solution for academics – the OP1420 Real-Time Microgrid PHIL Test Bench together with Bitslismen's learning hardware labs, such as the Power Labs Ecosystem, the solar and wind power system and more. This combination will allow students and academics to broaden their horizons by learning from and working with power generators, microgrids, inverter-based technologies, and concepts in renewables.

Access the QR code to watch the webinar that shows how OPAL-RT and Bitlismen's solution offers one of the highest performance and versatile setups in the market. Watch now >

ABOUT US

Founded in 1997, OPAL-RT TECHNOLOGIES is the leading developer of open real-time simulators and Hardware-In-the-Loop testing equipment for electrical, electro-mechanical and power electronic systems.

OPAL-RT simulators are used by engineers and researchers at leading manufacturers, utilities, universities and research centres around the world.

The company's core software, RT-LAB and HYPERSIM, enables users to rapidly develop models suitable for real-time simulation, while minimizing initial investment and their cost of ownership. OPAL-RT also develops mathematical solvers and models specialized for accurate simulation of power electronic systems and electrical grids. RT-LAB, HYPERSIM and OPAL-RT solvers and models are integrated with advanced field programmable gate array (FPGA) I/O and processing boards to create complete solutions for RCP and HIL testing.

RT22

ENERGIZING TOMORROW

Montreal | October 18-21

Join us in Montreal on October 18-21 to the OPAL-RT's 14th annual conference on real-time simulation.

Scheduled events include demonstrations, meetings with OPAL-RT subject matter experts, a variety of papers, and an exhibit floor of companies displaying their own recent advances in the industry. We also aspire to have numerous networking opportunities available for attendees, hence the importance we place on providing exquisite breakfast, lunch, cocktail, and diverse entertainment options for all participants.

opal-rt.com/RT22

Register HERE

SCAN QR CODE FOR RT22 REGISTRATION