

MICROGRID

REAL-TIME SIMULATION



OPAL-RT
TECHNOLOGIES

WWW.OPAL-RT.COM

Leading the way in microgrid laboratory testing

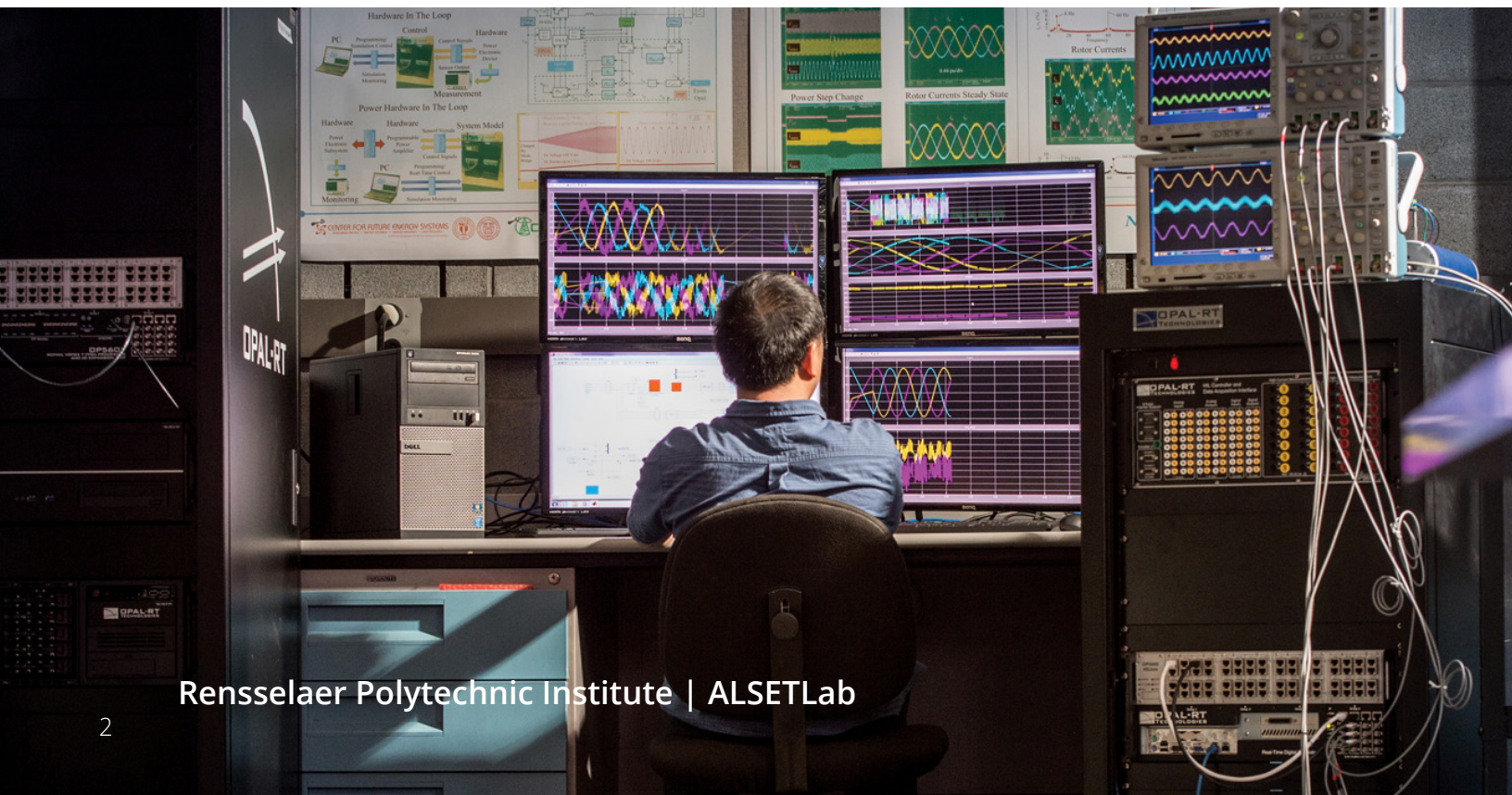
OPAL-RT's mission is to make the benefits of fast and real-time simulation available to as many engineers working on microgrids as possible. Whether you are in industry or academia, we have you covered.

While microgrids and their Distributed Energy Resources (DERs) offer operational and economic benefits, they differ substantially from traditional power grids bringing challenges currently being addressed by utilities, equipment providers, system integrators and academics.

In contrast to a typical distribution feeder, microgrids may operate independently, export power to the main grid and have different topologies involving AC, DC or a combination of both. Their control and protection systems can be complex (i.e. multi-level and distributed) involving equipment from multiple vendors making interoperability during key functions (e.g. islanding) a concern. As with other electrical systems, field testing of microgrid products and integrated systems on live grids can be risky.

For these reasons, many microgrid applications are well suited to Hardware-in-the-Loop (HIL) and Power Hardware-in-the-Loop (PHIL) testing. To the extent that HIL is recommended by the IEEE Standard for the Testing of microgrid Controllers (IEEE 2030.8-2018).

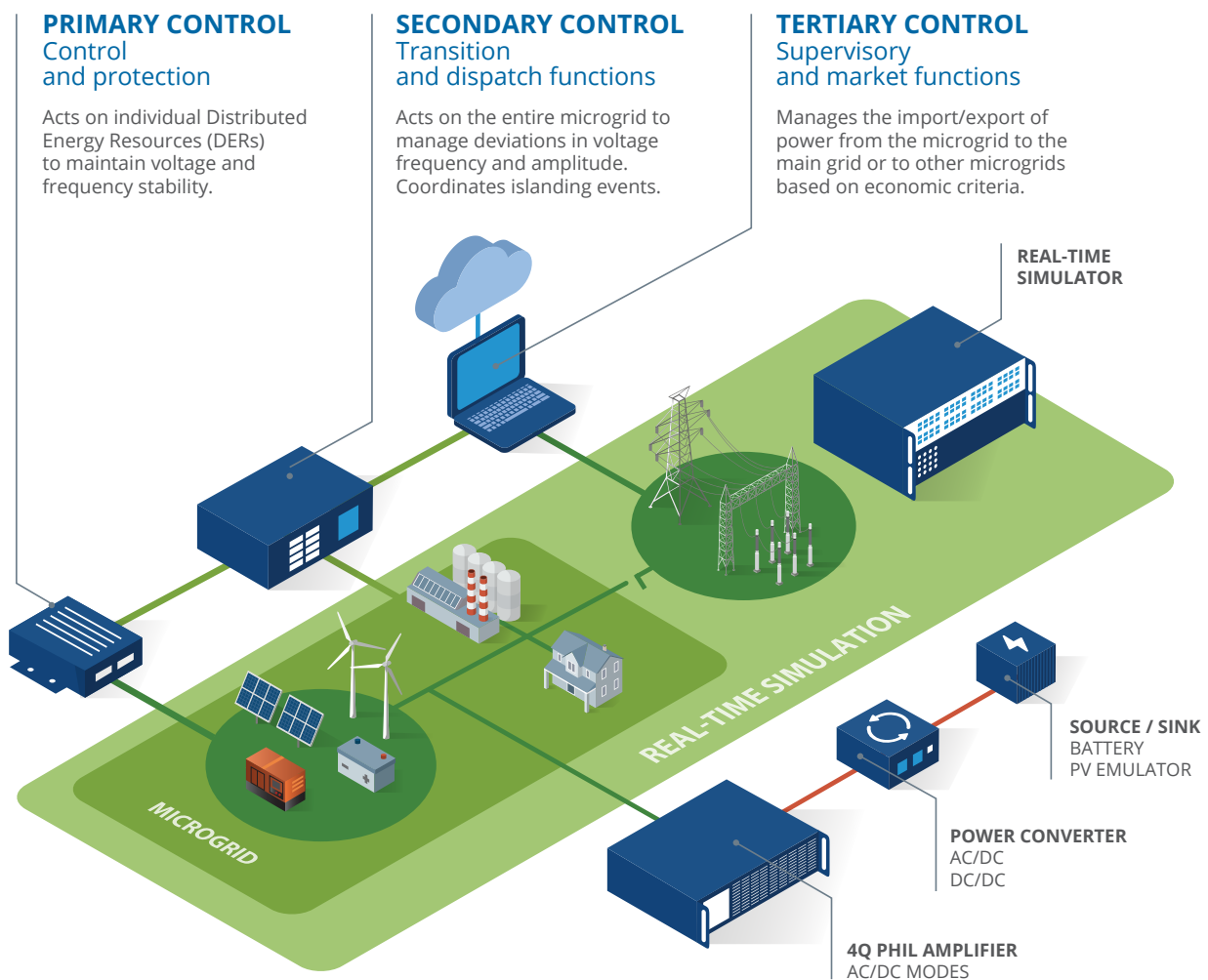
OPAL-RT TECHNOLOGIES has recognized the power of HIL and PHIL, and over the last decade, we have strived to help engineers employ these types of Real-Time Simulation for their microgrid projects. For the next decade, OPAL-RT will also offer advanced solutions for faster-than-real-time software-in-the-loop solution (SIL) to analyse the integration of very large number of DER and microgrids to transmission and distribution systems.





Hardware-in-the-Loop (HIL) Testing

Connect control and protection devices to a real-time simulation of a power grid to study their functionality in a closed-loop setting. Devices are connected to the simulator via low voltage/current signals and industrial communication protocols.



Power Hardware-in-the-Loop (PHIL)

Emulate AC or DC grids to test power devices (inverters, rectifiers, batteries, etc.) under realistic conditions while incorporating closed-loop interactions with a real-time simulator. Requires a power amplifier or power supply based on specific application.

Hardware-in-the loop made for microgrids

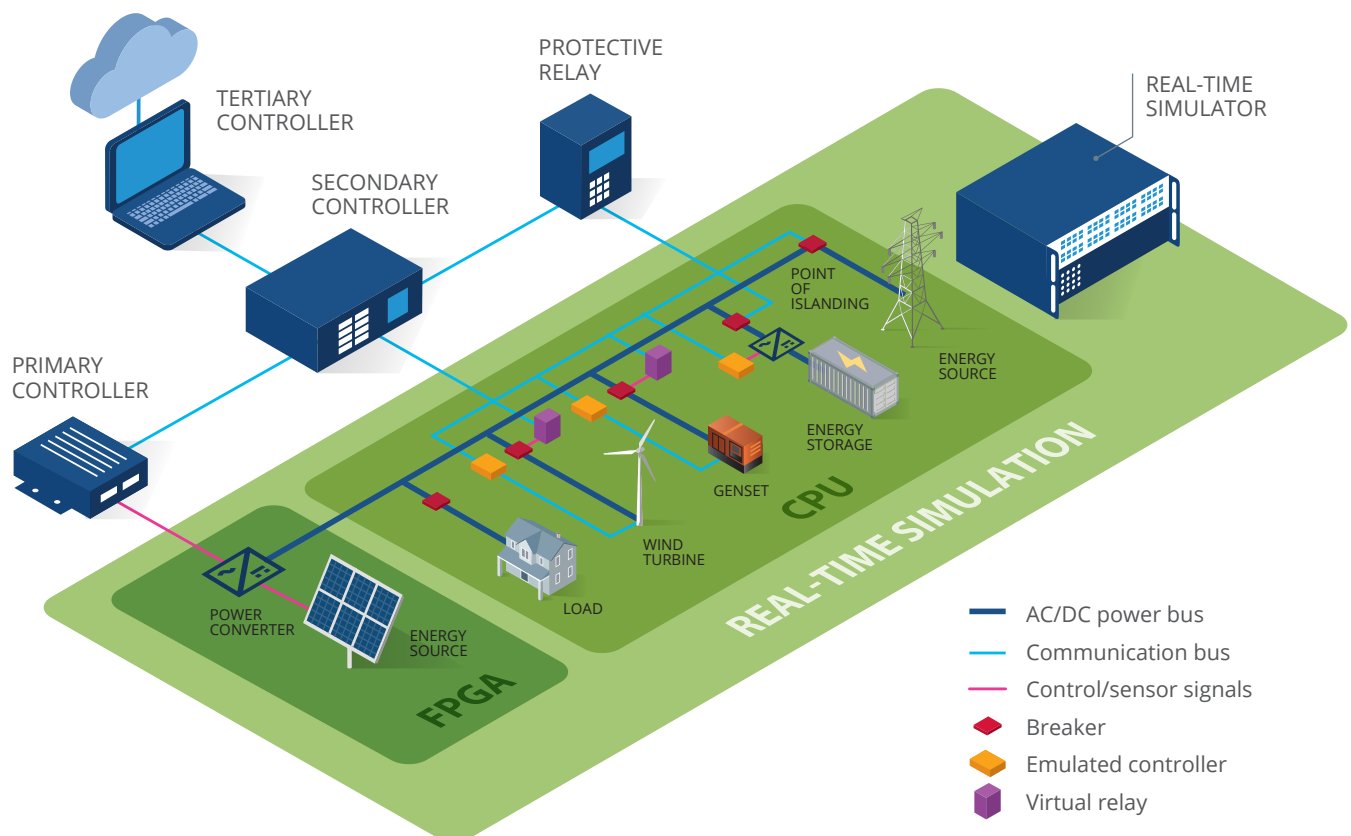
Microgrids export power to the main grid and have varying topologies involving AC, DC or a combination of both.

Hardware-in-the-Loop (HIL) testing has been embraced by the energy sector as a standard approach in the development, validation and integration of control and protection systems, including microgrid systems. HIL is performed by connecting devices via low voltage/current signals and industrial communication protocols to a real-time power grid simulation based on high-fidelity models. This model-based approach allows for a closed-loop interaction between the Devices-Under-Test (DUT) and simulator so that baseline and edge scenarios may be studied.

The safe low-power capability of HIL allows engineers to:

- Test and optimize devices to improve quality and detect flaws prior to release and/or installation,
- Accelerate research, product development and system integration,
- Demonstrate proofs of concept and new products

For microgrids, OPAL-RT offers flexible all-in-one HIL solutions capable of simulating the systems required for Primary, Secondary and Tertiary Control and Protection applications.





Unmatched connectivity

OPAL-RT simulators are made to connect to nearly every primary, secondary and tertiary control device via low-voltage analog and digital I/O modules, and industrial communication protocols.



Straightforward co-simulation

More than one OPAL-RT solver can be used simultaneously on the same real-time simulator using one or more processors and FPGA allowing for simple co-simulation configuration.



Test fast DER controllers

Test high-frequency DER power electronics controllers with our proven approach that combines sub- μ s EMT simulation with a low-latency simulator architecture and fast I/Os.



Emulate devices virtually

Setting up a testbench with real grid devices can be costly or sometimes unnecessary. Emulate additional control and protection devices virtually with our rich device and protocol libraries.

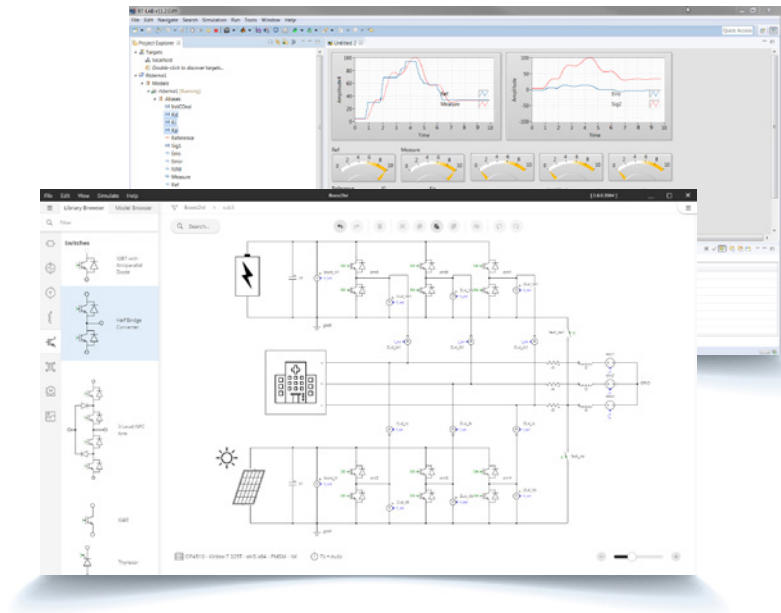


Software made for microgrids

Bring microgrid Simulink® models to real time with RT-LAB



Fully integrated with MATLAB/Simulink®, RT-LAB enables Simulink models to interact with real world in real time. This makes RT-LAB ideal for engineers to rapidly develop and validate their applications in real time, regardless of their complexity.



Features to get more done. Faster.



Rich Device and Example Libraries

Quickly bring-in real-time optimized devices or demo models to save time building your microgrid model.



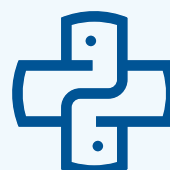
Built-in Scopes

View or record every signal being read, output or modeled by your real-time simulator.



Smart Protocol Emulation

Emulate communication protocols such as Modbus and IEC 61850 for quick and easy connections between simulator and equipment.



Automate Testing

Enhance productivity by creating custom scripts using Python to automate testing and report regeneration.



Toolboxes to cover every application

Microgrid applications vary significantly in terms of system frequency and scale. No single circuit solver is perfect for every application. Don't compromise. Choose the solver(s) that work for your application.



eHS FPGA-Based Power Electronics Toolbox Time step 100 ns - 1 μ s

Test high-frequency converter controllers with simulated power electronics. Users can achieve sub- μ s control loops between controller and simulator.



ARTEMIS CPU-based Electrical Toolbox Time step 10-100 μ s

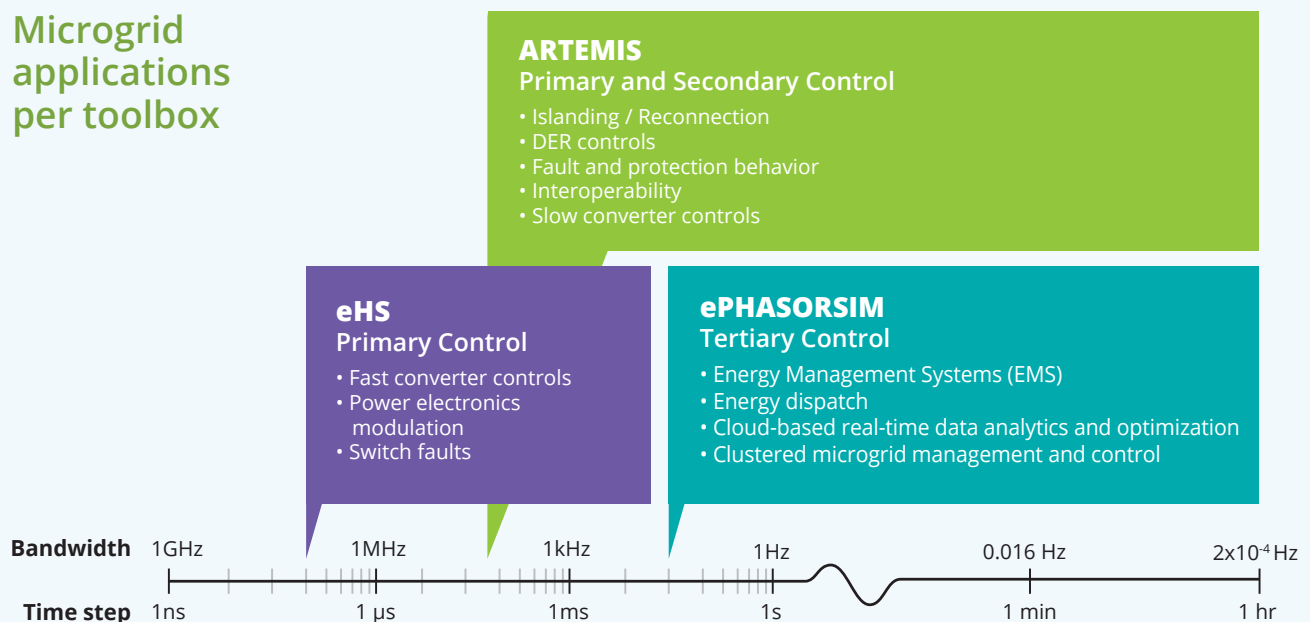
A real-time electromagnetic transient (EMT) toolbox for microgrids, ARTEMIS uses an advanced decoupling approach that does not add artificial delays to ensure model stability.



ePHASORSIM Electro-Mechanical Toolbox Time step 1-10 ms

A time-series phasor-domain solver used to simulate the transient stability of unbalanced feeders with several thousands of buses. Import from PSS/E, CYME and PowerFactory.

Microgrid applications per toolbox

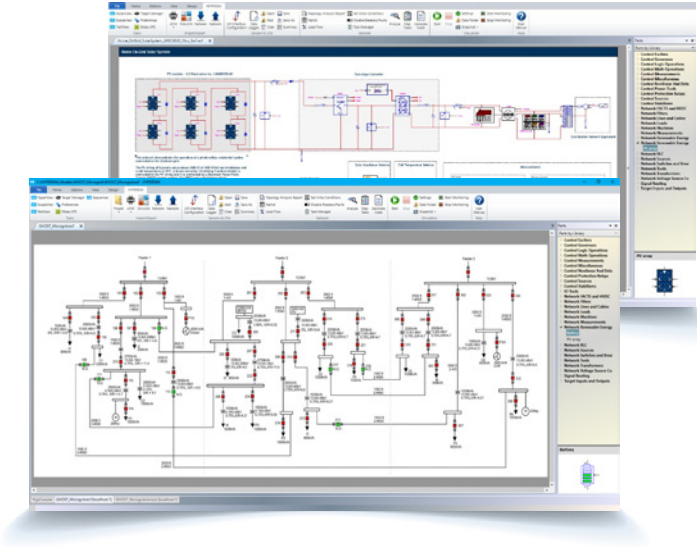


Discover the Power of HYPERSIM

The power system simulator of tomorrow



With its efficient signal processing and powerful test automation capabilities, HYPERSIM helps engineers to model their microgrid simulation project in one tool. Run accelerated simulations for in depth EMT analysis on their personal computer and going to real-time for large-scale Hardware-in-the-Loop (HIL) testing.



Made by power system professionals... for power system professionals



Proven result accuracy for any type of simulation

Benefit from decades of expertise and validation against field tests and other simulation software.



Compatibility with PSCAD, EMTP, Simulink, PSSE and more

Interface common simulation tools through model import or data synchronization using OPAL-RT's groundbreaking Unified Data Base.



Brute force processing power of μ Grid short line

Run fast and accurate microgrid real-time simulation below 20 μ s with up to 700 1-phase nodes with our latest Intel Processors.



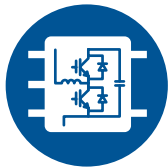
Accurately represent Distributed Energy Resources

Achieve optimal results with the capability to co-simulate pre-compiled real code supplied by plant manufacturers for Windows and Linux.



From modeling to real-time simulation in three steps with the fastest FPGA-based power electronics toolbox in the industry

Integrated directly with HYPERSIM. OPAL-RT's FPGA-Based Power Electronics Toolbox (eHS) is a powerful simulation tool for Hardware-in-the-Loop (HIL) testing. eHS enables the running of test sequences and on-the-fly changes to simulation parameters by using the Test Scenario feature. It allows the test engineer to jump from one set of component values to the next without stopping the simulation, and is the perfect system for all types of electrical conversion test applications.



1- Design

Develop your power electronics diagram with OPAL-RT's schematic editor.



2- Configure I/Os

Then, configure your I/O channels and compile your model for sub-microsecond time steps.



3- Perform tests

Finally, execute the real-time simulation and perform manual and automated tests.

Microgrid applications per toolbox

HYPERSIM Nodal Solver

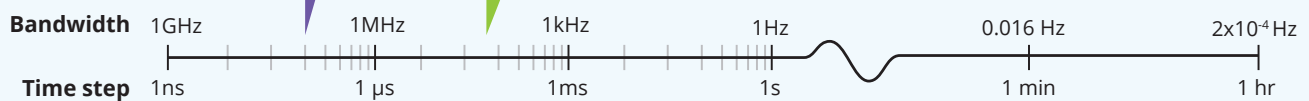
Primary, Secondary and Tertiary Control

- Integrate several microgrid and distribution systems
- Very large transmission grid including real-code supplied by wind and solar farm manufacturers

eHS

Primary Control

- Fast converter controls
- Power electronics modulation
- Switch faults



Hardware Platforms

Simulator platforms tailored to your needs



OP4510 | Compact desktop

Where price meets performance. The OP4510 is a compact but powerful simulator. More than ever, this real-time power grid simulator offers the best performance at an affordable price.



OP5707 | High-end performance

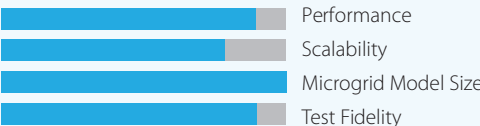
The OP5707 offers an unequalled level of high-end Intel® multi-core processor, FPGA performance and optical connectivity to meet top-level requirements.



OP1420 | Microgrid PHIL Test Bench

Quickly emulate grids and DERs with a vertically integrated turnkey solution.

Power Hardware-in-the-Loop (PHIL) is being adopted by power systems and power electronics laboratories across-the-world to improve the quality of teaching and research. However, since PHIL can be a complex, time-consuming and complex initiative, OPAL-RT has created the OP1420, a complete and vertically-integrated Power Hardware-in-the-Loop Test Bench for all microgrid laboratories.



**VISIT OUR
WEBPAGE**
OPAL-RT.COM/OP1420



The new XG series: Unmatched performance



One Processor. Double the Performance. Infinite Possibilities.

OPAL-RT is taking its simulators to another level with the new XG series. The new OPAL-RT's operating system OPAL-RT Linux, combined with Intel's latest technologies, and our unique toolboxes allow engineers to benefit from unmatched performance to develop, test, integrate and validate innovative microgrid components and solutions.

Performance

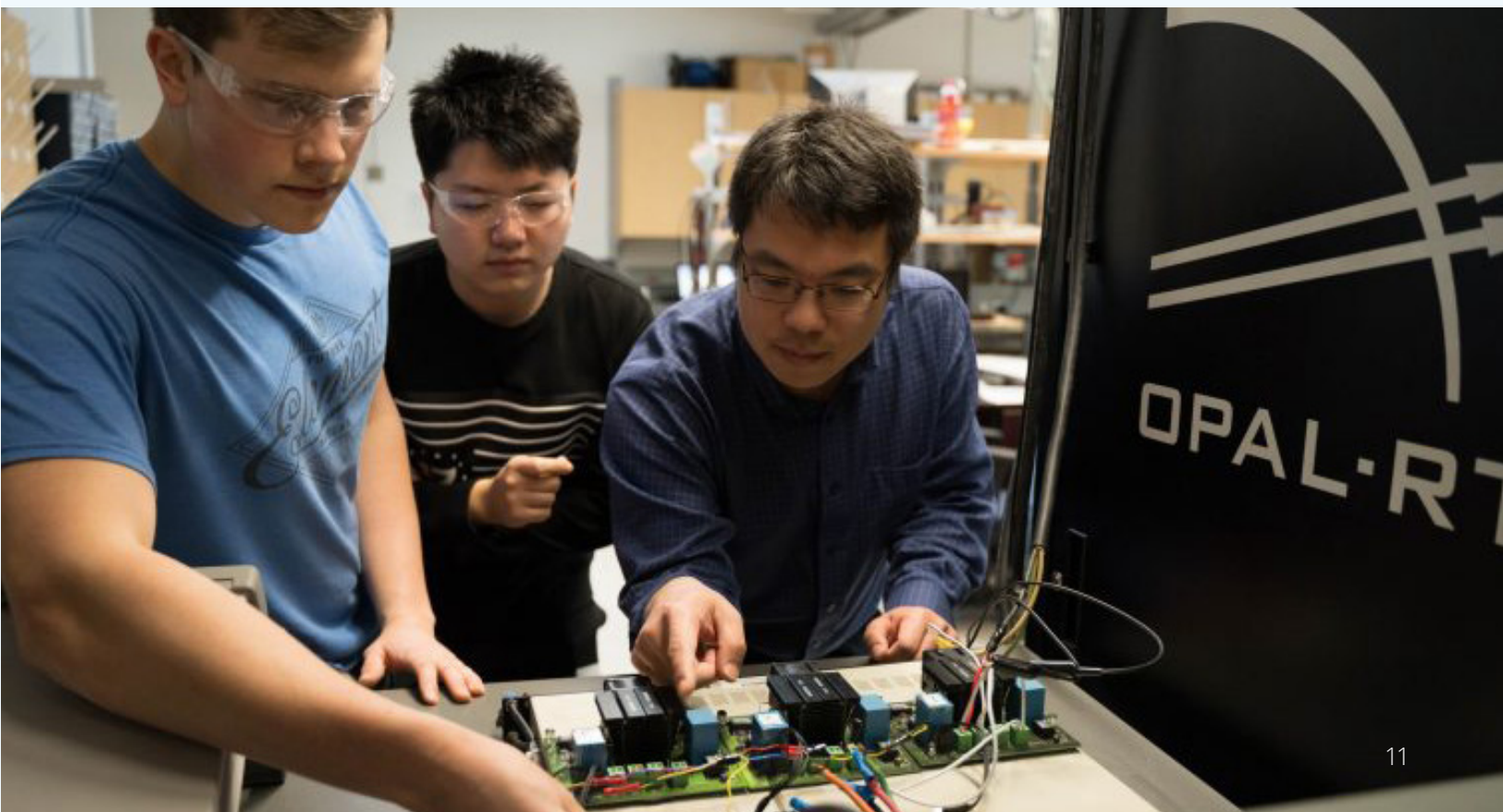
Up to 2.5x faster than the previous generation of simulators, the new XG series system is capable of simulating larger and more complex microgrid models using fewer cores, drastically reducing decoupling needs.

Scalability

With the number of cores on a single simulator increased from 4 to 44, the XG series allow users to model larger grids and/or reduce time steps for better accuracy.

Powered by Intel Processors

For over 20 years OPAL-RT's real-time simulators are based on Intel® processors that bring world-changing technologies to the market.



A global microgrid community

OPAL-RT Technologies is proud to have helped nearly 1000 clients from 40 countries bring their projects to life.

While today's microgrid community is a relatively small one, its growth and impact across the globe is massive. OPAL-RT is committed to making a positive impact in the microgrid sector not just through providing solutions but also through helping build community. We believe in actively promoting education via live and online events, so that can help spread innovation within the sector.

Most of the OPAL-RT microgrid's solution also apply to grids with a high penetration of renewables, and can be considered for these applications in a similar way.

Want to collaborate on a challenging problem?
Have a great webinar idea?
Write to us at opal-rt.com/contact-us

Academia



Manufacturers



Research Laboratories



Utilities



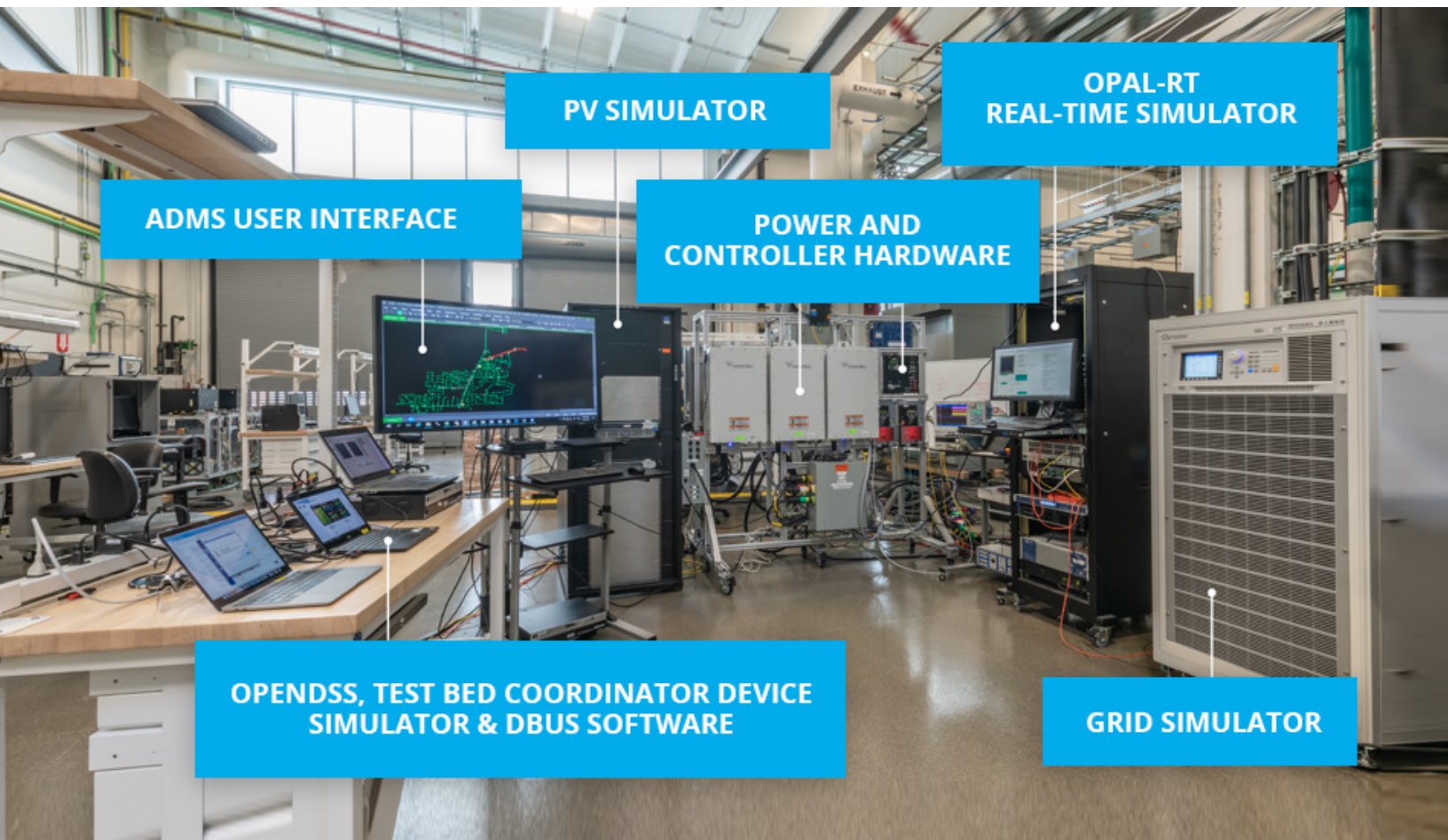
Success story



The National Renewable Energy Laboratory's mission is to transform the energy sector through the research, development, commercialization and deployment of renewable energy and energy efficient technologies.

NREL's Energy Systems Integration Facility (ESIF) is focused on bringing microgrid-enabling technologies from the factory into the field and has contributed to making a number of microgrid projects realities. One of the ways they do this is by providing state-of-the-art Hardware-in-the-Loop and Power Hardware-the-Loop facilities to manufacturers and integrators. This allows products, new technology and concepts to be thoroughly tested in a safe laboratory environment prior to installation in the field.

Along with HIL and PHIL, NREL's capability also includes the ability to test communication networks in real time to assess cyber performance and vulnerabilities. NREL also offer a vendor-neutral advanced distribution management system (ADMS) test bed for evaluating existing and future ADMS functionalities in a realistic laboratory setting. The test bed uses OPAL-RT's ePHASORSIM and ARTEMIS products interfaced with an OpenDSS power system simulation through the HELICS cosimulation platform developed by multiple DOE laboratories; and with power and controller hardware.



PV SIMULATOR

OPAL-RT
REAL-TIME SIMULATOR

ADMS USER INTERFACE

POWER AND
CONTROLLER HARDWARE

OPENDSS, TEST BED COORDINATOR DEVICE
SIMULATOR & DBUS SOFTWARE

GRID SIMULATOR



ABOUT US

Founded in 1997, OPAL-RT TECHNOLOGIES is the leading developer of open real-time digital 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.

OPAL-RT's unique technological approach integrates parallel, distributed computing with commercial off-the-shelf technologies.

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.



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