Bi-directional Test Solutions to Manage the Impacts of Electrification on the Grid

Martin Weiss
Product Director
NH Research (NHR)

Enabling Electrification
Agenda

- Who is NH Research?
- The Landscape of Electrification
- Test Solutions for Grid Management
- Industry Applications
Who is NH Research?

NH Research is a leading manufacturer of AC/DC test equipment and test systems used world-wide for testing of power electronics and battery products.

Over 50 Years delivering best in class test solutions
World Headquarters – Irvine CA
We Simplify Test

Flexible, Modular Hardware AND Software

- Performance & Safety
- Scalable Power
- Reduced Test Time/Cost

Product Portfolio
- Battery Test Systems
- Battery/Fuel Cell Test Systems
- Grid Simulators
- AC & DC Electronic Loads
- Bi-directional DC Source
- AC & DC Power Sources
- Power Supply Test Systems
Agenda

- Who is NH Research?
- The Landscape of Electrification
- Test Solutions for Grid Management
- Industry Applications
Electrification is Increasing Exponentially

Today’s Landscape:

Political & environmental
- Emissions regulations
- Grid & Power Management

Economical
- Decreased battery costs

What are impacts on the Utility Grid?
The Growth of Electric Vehicles

EV sales estimated at 57% of total passenger vehicle sales by 2040.

Electric buses, commercial vehicles are rising.

Source: BloombergNEF https://about.bnef.com/electric-vehicle-outlook/
Higher Voltage, Higher Power Trends

800 VDC

Image: Courtesy of Volkswagen Group (Porsche)

<500 VDC

Image: Courtesy of Tesla Motors

NHR 9300 Series

Constant Power Curve

High-Power Range

High-Current Range
Higher Voltage, Higher Power Trends

Image: Courtesy of Volkswagen Group (Porsche)

800 VDC

Image: Courtesy of Tesla Motors

<500 VDC

The power demand for a single Porche Car
In Year 2040 –

Wind and solar will make up almost 40% of world electricity

(up from 7% today)

Source: BloombergNEF:
https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/
Renewable Energy & Battery Storage

Key Applications

- Energy Storage – Emergency Power
- Grid Power Stability – Peak Shaving

Photo credit: GE Power
Many Areas to Test Across the MicroGrid

**IEEE-P2040**

**Tech Trends**
- Bi-Directional Sources
- Battery & Fuel Cell Emulation
- AC/DC Source & Loads
- Grid Simulators

**Applications**
- Vehicle to Grid (V2G)
- Solar PV Inverters
- Energy Storage
- Distributed Grid (DG) Inverters
Agenda

- Who is NH Research?
- The Landscape of Electrification
- Test Solutions for Grid Management
- Industry Applications
AC Power Distribution is Bi-Directional

Transportation Electrification & Energy Storage is Bi-directional

Key Advantages

- Modern Power Flows
- Accurate Simulation
- Real World Conditions
- Test Efficiently & Safely
- Energy Savings
- Future-proofing
Grid Simulation & Battery Emulation

Faster, scalable & more repeatable testing of emulating bi-directional power profiles.

Grid Simulation  Emulating a Charger  Emulating ESS
Testing with Batteries is Costly

- Preparing the Battery for Test → Time
- Battery Availability → Project Time
- Battery Effects → Test Repeatability
- Battery Safety Risks → Lab Safety
- No Corner Cases → Limits Test Coverage
Wide Operating Envelope

The Grid  Charger  Electric Car  Battery

AC to DC Grid Sim  DC to AC Bi-directional Power

What text to put here?
I didn’t put products because they are not introduced yet.
Modularity for Today & the Future

Covers All Power Levels from 100kW to 2.4MW

You Control Size

100kW

100kW

100kW

200kW

100kW

300kW
9430 Regenerative 4-Quadrant Loading
Up to 1200 VDC on 9300 Series

Simulate Any Power Factor/Current Control

Simulate Any Combination of Load Profiles

Power Factor

Crest Factor

Asymmetrical

1 Harmonics

Inrush

0 PF (Leading)

Unity

0 PF (Lagging)

0.5 PF (Leading)

0.5 PF (Lagging)
9410 Regenerative Grid Simulator
Up to 1200 VDC on 9300 Series

NHR 9410 Grid Simulator
The Right Tool for Simulating AC Voltage Disturbances
Utility Grid Load Testing

Utility Grid

Test effects of energy to & from the grid

9410/9420
Grid Simulator/AC Source

9430
4 Quadrant Load
Traditional Loads Vs. Regenerative

Traditional Loads
- Heat Loss
- Poor Working Conditions
- Operating Costs
The Benefits of Regenerative Loads

- Reduce Waste Heat
- Recycle Energy >90% back to UUT or facility
- Huge Cost Savings

Regenerative Loads

Utility → Facility → Regenerative NHR Loads (9200, 9300, 9410, 9420) → Unit Under Test (UUT) → Chiller

<10% power
9430 Regenerative 4-Quadrant Loading

NHR 9430
Regen 4 Quadrant Load

Simulate Any Power Factor/Current Control

0 PF (Leading)  0 PF (Lagging)
Unity

0.5 PF (Leading)  0.5 PF (Lagging)
9430 Regenerative 4-Quadrant Loading

NHR 9430
Regen 4 Quadrant Load

Simulate Any Combination of Load Profiles

Power Factor
Crest Factor
Asymmetrical I Harmonics Inrush
You Control How to Use System

Write your own software - Enerchron Test Executive - Work with your favorite Integrator

Flexible Data Control Options

Touch I/F

Remote

Enerchron

LabVIEW
Agenda

- Who is NH Research?
- The Landscape of Electrification
- Test Solutions for Grid Management
- Industry Applications
EV Onboard Charger

Electric Vehicles

Test effects of energy to the grid

9410/9420 AC Source

9200/9300 Battery Emulator
Vehicle 2 Grid Testing

Electric Vehicles

Test effects of energy to the grid

9410/9420
Grid Simulator/AC Source

9430
4 Quadrant Load
Wind to Grid Testing

Wind Sources (DG)

Test effects of energy to the grid
Solar PV to Grid Testing

Residential Solar PV

Test effects of energy to the grid

9200/9300 Solar Emulator

9410/9420 Grid Simulator/AC Source

DC-AC Inverter
Utility Grid Load Testing

Utility Grid

Test effects of energy to & from the grid

9410/9420
Grid Simulator/
AC Source

9430
4 Quadrant Load
Energy Storage Systems

Residential or Large Scale Energy Storage

Example Applications:
- Emergency Power
- Grid Power Stability/Peak Shaving

Test Effects of Energy to the Grid

- 9410/9420 Grid Simulator/AC Source
- 9200/9300 Battery Emulator
- DC to AC Inverter
Worldwide Service & Customer Support

Need help?  
Contact us for more info.

We help you achieve your goals.

- **Expertise** – application, product design, engineering specialists on stand-by
- **Access** – rapid response times by phone, email, and site-visits
- **Support** – technical experts, training, diagnostic/calibration tools, and replacement parts to resolve problems quickly

“At NHR, we consider every customer a **partner**.”

Phone: 949-474-3900  
Email: [sales@nhresearch.com](mailto:sales@nhresearch.com)  
Website: [www.nhresearch.com](http://www.nhresearch.com)

NHR Headquarters  
16601 Hale Ave  
Irvine, CA 92606