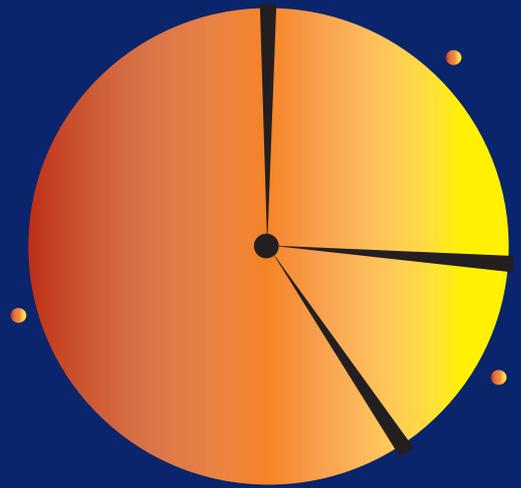


# Ballard Power



## Ballard Power Standardizes on IncuityEMI™ BI for Manufacturing Software For Unifying Portal Access to 35 R&D, Production & Field Test Databases

Our company has always been a highly intensive R&D operation, constantly testing and evaluating PEM technology in our development laboratories, in production operations and in field tests around the world of both our fuel cell-powered cars and buses – in partnership with DaimlerChrysler, Ford and Honda – and of our portable and stationary fuel cell power generators.

Good feedback is critical to our product and technology development programs. In our two plants at our suburban Vancouver headquarters we have more than 20 processing cells in our production facility and we're installing up to 100 test stations in our lab and test facilities. We deploy a total of about 35 databases throughout our company for both plant operations and enterprise business applications. Our production-oriented databases include more than 10 IndustrialSQL Server™

By: William Blakeman, Sr. Engineer, Team Leader, Integrated Plant Data Systems  
Ballard Power Systems, Inc., Burnaby, BC, Canada

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Ballard Power Systems is the world leader in development of zero-emission proton exchange membrane (PEM) fuel cells that convert hydrogen into electricity for fuel cell and other electric vehicles and power conversion products. The company was founded in 1979 to conduct research and development in high energy lithium batteries and began developing PEM fuel cells in 1983. Proof-of-concept fuel cells were introduced between 1989 and 1994, followed by pre-commercial prototypes and initial commercial products that proved the concept of fuel cells as viable alternatives to conventional vehicle fuel and electric power generation technologies.

historians from the Wonderware unit of Invensys Systems; the Wonderware InTrack™ product genealogy system; our WebSpec product specification management and reporting system; and Microsoft SQL Server Reporting Services. We also deploy a Fourth Shift enterprise resource planning (ERP) system for corporate applications.

Since each of these applications was created independently of the others, we had a problem that's typical of most manufacturing companies: although we had all the data we might ever need about our operations, it all existed as separate silos of information. There was no convenient way to connect them so that we could do better analysis of data, put it in the proper context for multiple types of users, and then share it throughout the company over the Internet.

Our information technology (IT) department management set out a few years ago to solve this data management problem and we created an Integrated Plant Data Systems group to develop and implement an answer. We looked at a number of potential solutions but most either required custom code development, which would have been expensive to develop and maintain, or they required maintaining duplicate copies of various data sources, which raised other issues with database maintenance and integrity. In both cases, we simply wouldn't have one version of the truth.

In early 2005 we found and have now deployed a single solution that meets our needs – the IncuityEMI™ business intelligence for manufacturing software from Incuity Software, Inc., based in Mission Viejo, California. Incuity has now:

- Enabled us to have secure access to all of our data sources from within a single portal, yet allow each to remain the master of its own data
- Given us powerful yet versatile toolsets for analysis and reporting of data, within the contextual framework of the requesting user

- Facilitated the sharing of information over the Internet, using standard browsers rather than having to install client software on every PC
- Allowed users to manipulate their requested data within application software they already know how to use, such as spreadsheets, and other common office applications

## Connecting to Large & Still-growing Databases

As valuable as all our data collection is for providing feedback for R&D and production efforts, the management and usage of the massive volumes of information collected from around the world was an issue in and of itself. It's a never-ending data gathering process.

For example, in our product tracking and genealogy applications at headquarters, we record approximately six million transactions a day. We're already collecting up to 20 million transactions a day and when we've completed our planned 100 test stands, we estimate we'll be handling about 40 billion transactions a day – based on collecting data from 80,000 tags running at 100 millisecond resolution.

In addition, we have field trials under way all over the world. We have vehicle tests running in 14 countries that generate about six million transactions a day. Every time one of these vehicles pulls into a hydrogen refueling station, the driver pops a PCMCIA data collection card out of the dashboard, plugs it into a remote data entry port, and the vehicle's operating data since the last refueling stop is sent to our home offices over the Internet, into one of our IndustrialSQL Server databases.

Similarly, we collect another six million transactions a day, over the Internet, from our household power units under test in Japan. These units convert natural gas into hydrogen for producing electricity, hot air heating and pure water for each household.

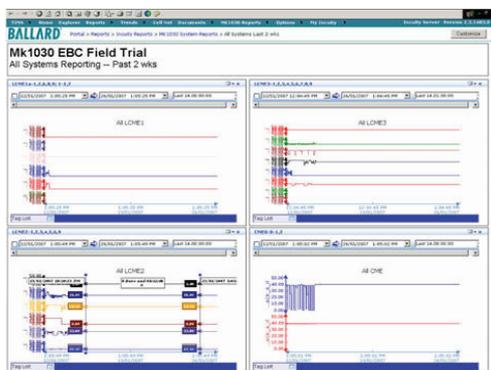
## Closing the Loop for R&D, Production

The reason we generate so much data is simply because Ballard is still heavily oriented to research in fuel cell technology, which is an extremely complex analog system. Much of our R&D work therefore involves data analysis that is much like solving a simultaneous equation. Each time one small element of the process is changed or adjusted, it has ripple effects on all other factors in the process. This not only generates copious amounts of new data but it presents significant analysis issues for both our IT and research staffs.

Because of the intricacy of our membrane electrode assembly (MEA) fuel cell units, we need to collect extremely high volumes of information on both the vehicle and stationary power applications. This has presented severe problems in the past because our analysis systems weren't automated. We had to generate CSV files from individual sets of test data and run them through a huge data cruncher – which basically was a very big Excel spreadsheet, with hundreds of macros that performed many, many calculations and generated a set of specific results from the raw data. This processed data was then saved in its own CSV file as part of what grew to be a 10 terabyte databank server. There are now about 20 million CSV files sitting in that data bank, which is extremely difficult to search through in order to do any analysis across a range of tests over a particular period of time.

This year, starting with the field trial program for the home power units we're testing in Japan, we're now using the IncuityEMI calculation engine to simplify this analysis activity. As soon as a test or a field trial period is finished, the calculations are run automatically within Incuity and the resultant data is stored in the IncuityEMI SQL database so it's ready to report against. This now puts all our test results in one location and when we run our reports,

it's a much quicker task because we don't have to run huge calculations against the enormous amount of raw data. The report is generated simply by working against the resultant values that are already sitting in Incuity.



Incuity provides a single view of field trial data sent in to headquarters offices over the Internet from MK1030 residential cogeneration units.

On the manufacturing side, our two primary systems are a real-time database for the production line data and an InTrack system for product tracking and genealogy. The problem has been that neither system can interact with the other and our people would like a bridge between the two. They know when a part was made and which machine it was made on, from the product tracking and genealogy, but they would like to see what happened to that part in the field trials. They want to see all its data correlated, from end to end, so that if it's been rejected in testing they'll know what was wrong with it and what the source of the problem was. They don't want to have to run additional analyses of both sets of data.

Our Incuity solution was to build an Excel spreadsheet that allows our staff to enter a serial number for that device from the product tracking and genealogy database in order to pull out all information as to which line stations that serial number went through during its production history. Users can then set "fence post" parameters in Incuity that represent the start and end times in the IndustrialSQL Server database and the system pulls up all the process data related to those serial numbers in chart form. The spreadsheet lists a golden batch at the top of the sheet to compare product and process data for a whole range of serial numbers. They can get several hundred units at a time plugged in and easily see what differences might have occurred between batches or what might have caused the problem in the production system. It may have been something as simple as a setpoint that was set incorrectly, a machine wasn't configured properly, they used the wrong batch of materials, or the batch had expired. This last point is very important in the making of fuel cells.

Our MEA fabrication process can be quite tricky because some of the raw materials we use have a very short shelf life, measured in hours, not days or weeks. If someone forgets and uses materials that may have expired, that fact pops right up on the analysis sheets straightaway. We know immediately that we'll need to reject other materials from that batch and we can make production system adjustments before those materials are even assembled in other product batches.

## Linking the Enterprise

With IncuityEMI, we're no longer dealing just with the production and testing environments. Another of our goals was to help bring the scope of our research down to manageable size and to provide cradle-to-grave genealogy. Incuity provides the ability to look at multiple data sources and manipulate data from different applications so we can do more sophisticated analyses. We started

## Corporate Offices

20532 El Toro Road, Suite 309  
Mission Viejo, CA 92692  
+1 (888) INCUITY (462-8489)  
+1 (949) 465-0390  
headquarters@incuity.com

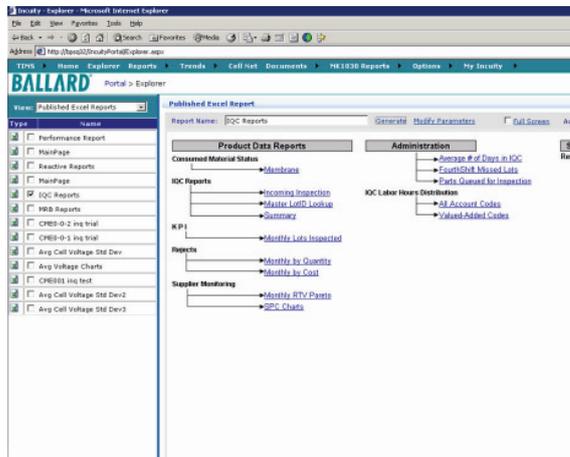
## Additional Locations

Nevada  
Massachusetts  
Texas

Burlington, Ontario, Canada  
Duesseldorf, Germany  
Johannesburg, South Africa

with data from our production test stands and field test operations, which are housed in our IndustrialSQL Server databases. We then connected to our InTrack manufacturing execution system (MES) to be able to follow raw materials, components and finished goods all the way from manufacture through to field testing, which we hadn't been able to do before.

The next stage of development was to link Incuity so it could pull in information from our ERP system. This enables our people to factor in cost, supplier and material information. If testing indicates that there were problems with a particular batch of material, we can query the ERP system to find out what supplier produced it, who delivered it, where it had been in inventory and what the cost basis was. This is where we see the huge advantage of Incuity, in being able to combine data from all these different production and business data sources into a single analysis and reporting environment.



It's given our researchers capabilities they've never had before. For example, people may want to see the results from when a particular fuel cell stack was assembled, when it

The Incuity Portal provides an overview of all Excel data sheets by type of report. Users can quickly drill down to find the information they need.

passed production tests and how it's performed in field testing. We couldn't do this before, but with Incuity we can overlay the field trial data on the production test data records to see what the differences are. We can even include finance reports that are run against our ERP system. We've taken all of our old Crystal Reports files and converted them using SQL Reporting Services. We now have a financial tab in the Incuity portal so that our finance staff can go into Incuity to pull up their financial reports that are run against the

Fourth Shift data. The end result is that Incuity is becoming the only place to find any data, no matter what it is, in the entire company – including information that isn't directly related to the manufacturing process.

## Secure Access & Sharing of Data

A big factor in our quick adoption of the Incuity solution was that it isn't a rip-and-replace system. It complements our existing systems, as diverse as they are, and actually enhances our return on investment in all of them because it allows us to view data from any of them in a single environment. All the information existed before, but it was completely unrelated and pulling it together proved to be far too labor intensive. Furthermore, users logged in from everywhere and basically did their own thing. We now can manage data access in our Integrated Plant Data System, based on IncuityEMI. We use the built-in security features of Windows and Incuity to make sure that people can only work with specific data for which they're authorized.

This high level of security answers several needs. It allows us to provide Internet access to clients who need to see data related to their projects, while allowing us to restrict access to critical production, test and financial data. We can keep people's data access separate and secure based on their roles in the organization, as determined by their log-ins. This is especially important now that we can connect to our ERP system. Since Ballard Power stock is dual-listed on the Toronto Stock Exchange (TSX: BLD) in Canada and on the Nasdaq national market (NASDAQ: BLDP) in the United States, we have to complete audits required under the Sarbanes-Oxley Act (SOX). This means that while we do want to integrate financial data with our operational data in order to make better business decisions, we have to maintain the security of both.

With Incuity, we have the ability to do trial SOX audits on a regular basis so that when we do the real audits we know we're going to pass. Our auditors actually spent time trying to break the security of our Incuity portal. As they put it, they weren't able to "crack the system" and were satisfied that it was secure enough to meet SOX requirements.

As we add enterprise data to our manufacturing intelligence mix, Incuity is emerging as the place to find data in the entire company – no matter what it is.



ISV/Software Solutions