



*Bring Power to Innovation!*



A world leader in developing innovative tools for power grid assessment, monitoring, analysis, operation, control and optimization.

# Corporate Profile

## Bigwood Systems, Inc.



“BSI’s On-line VSA is simply the best in the field.”

— CAISO project manager

“BSI’s On-line TSA is a superb product.”

— TEPCO chief engineer

## Our Company

Bigwood Systems, Inc. (BSI) was founded in 1995 to provide the utility industry with high-quality software solutions growing out of cutting-edge research and development work.



BSI is well recognized as a world leader in developing innovative tools for power grid assessment, monitoring, analysis, operation, control and optimization to provide our customers effective solutions to support the highest quality of reliable, safe and sustainable electrical power in their communities. BSI has an exceptional track record in developing on-line EMS solutions and

off-line planning tools in both transmission and distribution networks for bulk electric system installations.

The company invented and holds rights to eleven U.S. patents and four overseas patents in this area of expertise. Today, the BSI corporate office is located in the Cornell Business and Technology Park, Ithaca, NY 14850, USA with branch offices in San Francisco, Taipei and Abu Dhabi.

The BSI staff has an extensive background in the electric and gas utility business, with a high degree of technical expertise and experience in utility research and applications. Consultation, training, technology transfer and education are important components of our solutions to better serve our customers.



**Dr. Hsiao-dong Chiang, Founder and President of Bigwood Systems, Inc.**

“BSI was founded to develop innovative technologies and to apply them in a cost-effective fashion to solve critical problems facing the industry related to on-line operations, off-line planning, power market and engineering analysis and design.”



**Mr. Pat Causgrove, General Manager of Bigwood Systems, Inc.**

“As BSI’s General Manager, it is my great privilege to help lead our talented staff in providing innovative products and outstanding service to our customers. Please be assured that we will continue to be committed to delivering quality solutions to the utility industry.”

## Our Customers

BSI has proudly served over 30 major utilities around the world including the following world-class companies:



The largest utility in the world



The largest ISO in Western USA

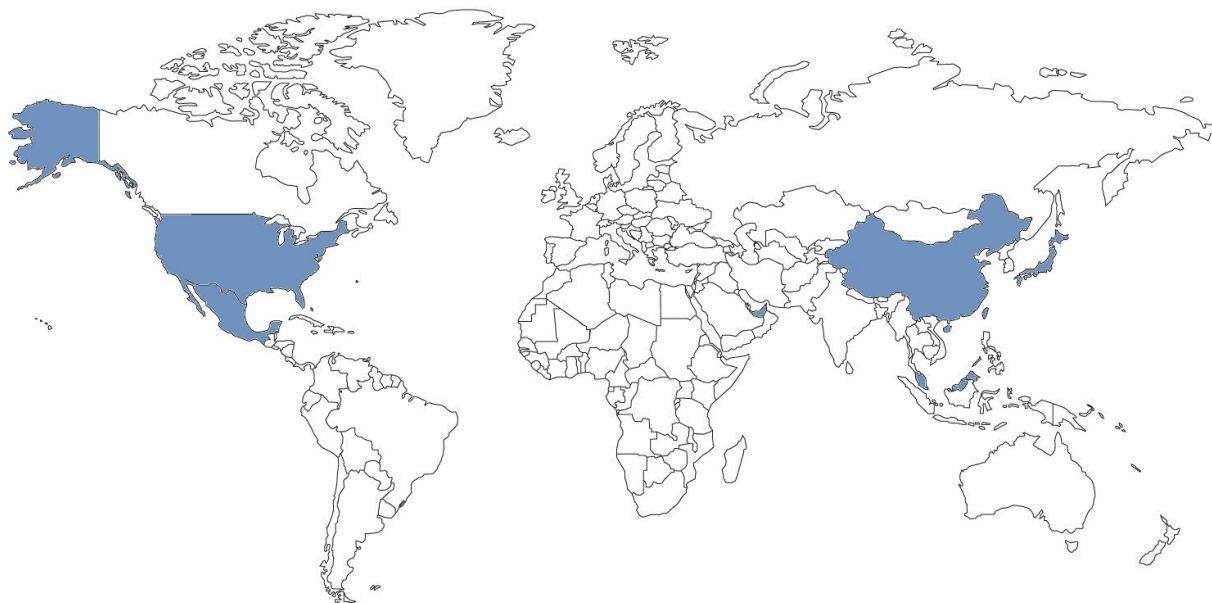


The largest investor-owned utility in the world

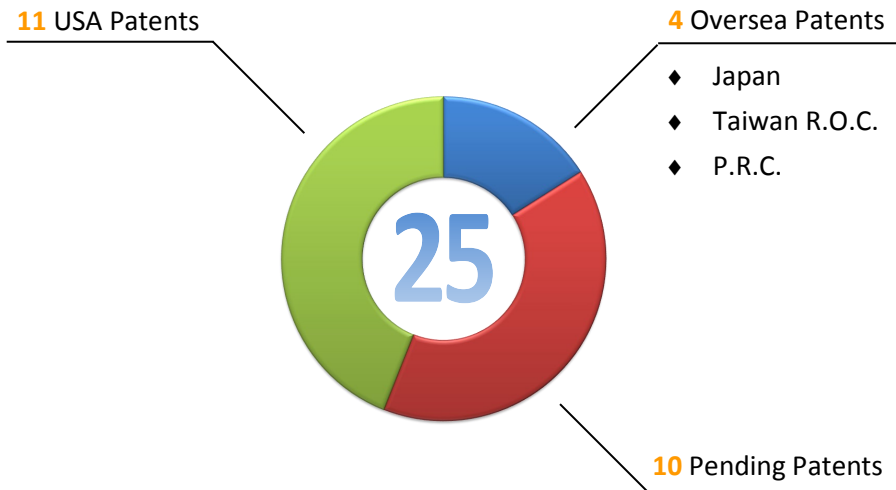


The largest power transmission company in the USA

Our worldwide customers and industrial alliances:



## Our Patented Technologies



Examples of our patents:

**U.S. Patent 5,483,462;** "On-line Method for Determining Power System Transient Stability" Date of Patent, Jan. 9, 1996

**U.S. Patent 5,642,000;** "Method for Preventing Power Collapse in Electric Power Systems", Date of Patent, June 24, 1997

**U.S. Patent 5,796,628;** "Dynamic Method for Preventing Voltage Collapse in Power Systems", Date of Patent, August 18, 1998

**U.S. Patent 6,868,311;** "Method and System for On-line Dynamical Screening of Electric Power System" Date of Patent, Mar. 15, 2005

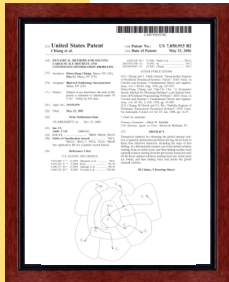
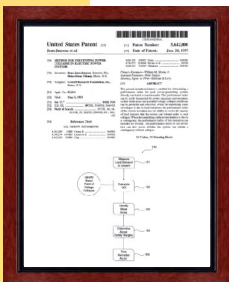
**U.S. Patent 7,483,826;** "Group-Based BCU Methods for On-Line Dynamical Security Assessments and Energy Margin Calculations of Practical Power Systems" Date of Patent, Jan. 27, 2009

**U.S. Patent 7,761,402;** "Group-Based BCU Methods for On-Line Dynamical Security Assessments and Energy Margin Calculations of Practical Power Systems" Date of Patent, July 20, 2010

**Taiwan Patent 083962;** "Dynamic Method for Preventing Voltage Collapse in Power Systems", Date of Patent, August 18, 1998

**Japan Patent 4,611,908;** "Group-Based BCU Methods for On-Line Dynamical Security Assessments and Energy Margin Calculations of Practical Power Systems" Date of Patent, Oct. 22, 2010

**People's Republic of China, Patent ZL 038,089,55.6;** "Method and System for On-line Dynamical Screening of Electric Power System" Date of Patent, Dec. 10, 2008





## Our Products

### TEPCO-BCU

Transient Stability Analysis and Enhancement

### VAS&E

Voltage Stability Analysis and Enhancement

### ECLIPS

Small-Signal Stability Analysis and Enhancement

### SSA&C

Static Security Assessment and Corrective Control

### SC-ATC

Security-Constrained Available Transfer Capability Analysis

### Super OPF

Comprehensive AC Optimal Power Flow with Static and Dynamic Constraints

### PMU-Based Real-Time Applications

### GOLD Suite for Operation and Planning

- ◆ GOLD-DPFLOW
- ◆ GOLD/Fault
- ◆ Harmonic Analysis
- ◆ Distribution State Estimation
- ◆ Service Restoration
- ◆ Voltage/VAR Control
- ◆ Loss Minimization

### GOLD Suite for Renewable Energy Management

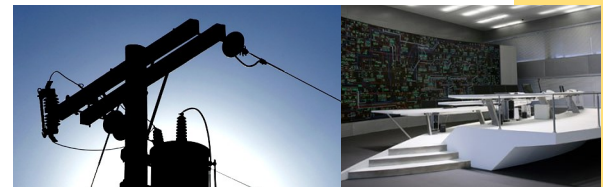
- ◆ CDFLOW
- ◆ ADC
- ◆ Nomogram
- ◆ Probabilistic Power Flow
- ◆ ADC Enhance/Volt/VAR
- ◆ Daily Switching Management Tool
- ◆ Short Term Forecasting



## ENERGY CONTROL CENTER



## TRANSMISSION



## DISTRIBUTION



## RENEWABLE & SMART GRID

**18 Patented Technologies owned by BSI have been embedded in Transmission Products.**

**TEPCO-BCU (TSA&E)**

TEPCO-BCU for On-line Transient Stability Analysis and Enhancement (TSA&E) performs transient stability assessment of the current operating condition, with fast screening of the contingency list into insecure, critical and secure contingencies. TEPCO-BCU not only provides fast screening and the severity levels of critical contingencies, but also develops preventive controls for insecure contingencies and enhancement controls for critical contingencies on large scale power networks.

**VSA&E**

Voltage Stability Assessment and Enhancement (VSA&E) package uses the most advanced and patented methods to rapidly calculate the exact nose point, the P-V, Q-V, and P-Q-V curves, and to perform fast contingency screening and ranking. Contingencies are classified by VSA&E into secure, critical and insecure contingencies, and for insecure and critical secure contingencies, VSA&E develops rapid, effective and economical control actions.

VSA&E offers multiple modes:

- ◆ VSA&E/RT: Real-Time Mode
- ◆ VSA&E/LA: Look-Ahead Mode
- ◆ VSA&E/Study: Study Mode
- ◆ VSA&E/DA: Day Ahead Mode
- ◆ VSA&E/STUC: Short TERM Unit Commitment
- ◆ VSA&E/Renewable: Renewable Mode

Dynamic System Analysis

File

Edit

Analysis

View

Help

TEPCO BCU Control Table

Contingency	Before Control CCT	After Control CCT	Target CCT	Computation Time (second)
\$3680	0.058	0.106	0.100	31.61

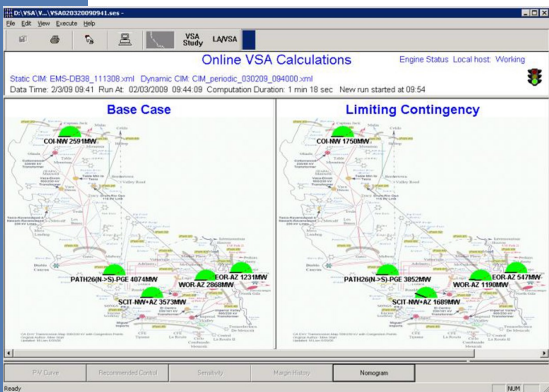
Control Details

Number	Apply	Location	Area	Type	Original amount	Control Amount	Final Amount	Upper Limit	Lower Limit
1	<input checked="" type="checkbox"/>	328 MUDDYRN	PE	Gen	J-117	36	-81	120 000	-120 000
2	<input checked="" type="checkbox"/>	328 MUDDYRN	PE	Gen	J-117	36	-81	120 000	-120 000
3	<input checked="" type="checkbox"/>	531 MUDDYRN	PE	Gen	J-117	11	-108	120 000	-120 000
4	<input checked="" type="checkbox"/>	531 MUDDYRN	PE	Gen	J-116	11	-105	120 000	-120 000
5	<input checked="" type="checkbox"/>	827 MONTGUR	PL	Gen	J-647	-93	353	734 600	403 400
Total redpatched real power							93		

Apply & Time domain

Apply & Save

Apply & SSA



**“BSI’s On-line VSA is simply the best in the field.”**

- CAISO project manager

**"BSI's On-line TSA is a superb product."**

— TEPCO chief engineer

## Distribution Products

**7 Patented Technologies have been embedded in the GOLD Suite products.**

### GOLD Suite for Operation and Planning

Global Optimal Linked Computer Package for Distribution System (GOLD) is an integrated set of computer packages for operating and planning distribution networks. The GOLD package and its core packages, Low-cost DSE and DPFLOW, provide a comprehensive toolbox for monitoring, analysis, optimization and control of electric utility distribution systems.

Throughout the world, growing electricity demand has placed increasing strain on the grid. The difficulty to build new transmission lines and invest in large power plants has increasingly placed the burden on distribution system to produce and distribute reliable electricity. The GOLD package offered by BSI is an effective tool set for system operators and planners to meet with this challenge.

Functionality examples of The GOLD Operation and Planning Suite:

#### Low Cost Distribution State Estimation

Patented technology for effective low-cost solution

#### Volt/VAR Control

Capacitor Placement for Loss Minimization

#### DPFLOW

Unbalanced Distribution Power Flow Analysis

#### Loss Minimization

Loss Minimization with Network Reconfiguration

#### Harmonic Analysis

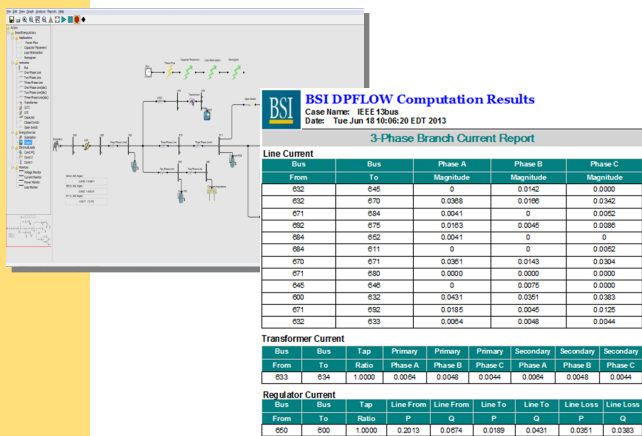
Distribution System Harmonic Analysis

#### Fault Analysis

Distribution System Short Circuit Analysis

#### Service Restoration

Distribution System Fast Service Restoration

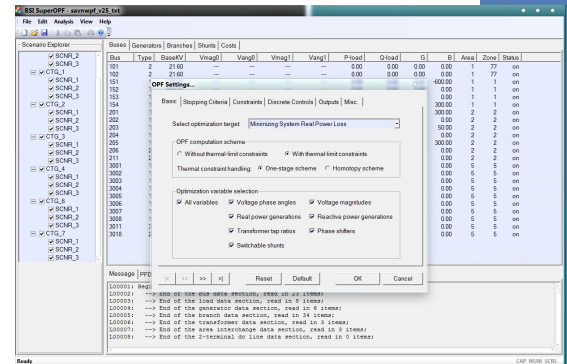


## Transmission Products (continue)

### Super OPF

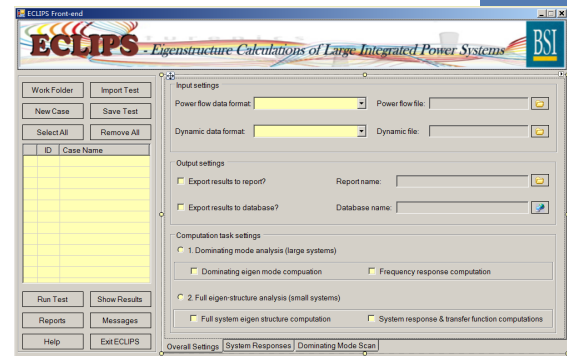
SuperOPF is a powerful, large-scale optimal power flow (OPF) engine which has comprehensive modeling capability, and a patented non-linear AC OPF solver. SuperOPF is able to calculate the true LMP, perform multi-scenario and multi-contingency optimization and handle renewables.

Another distinguished feature is the co-optimization framework that correctly accounts for contingencies, ancillary services, renewable energy, static constraints and dynamic constraints in determining both dispatch and price. It is capable of handling the dynamic stability constraints of a large set of contingencies.



### ECLIPS

ECLIPS (Eigen-structure Calculation of Large Integrated Power Systems) is dedicated to performing on-line small signal stability analysis and control for large power systems. It has a computation engine for dominant eigen-mode computation and full eigen-structure computation.



## More Transmission System Analysis Tools:

### SSA&C

Static Security Assessment and Control

### SC-ATC

Security Constrained Available Transfer Capability

### RTCC-DACS

PMU-based Real-Time Critical Contingency Detection and Control System

### PMU-based Real-Time ATC&E

PMU-based Real-Time Available Transfer Capability and Enhancement

### PMU-assisting Dynamic Modeling Correction



## Distribution Products (continue)

### GOLD Suite for Renewable Energy Management

GOLD for Renewable inherits the key features of the GOLD package, which include comprehensive modeling capability and advanced computation and optimization capabilities. In addition, GOLD for Renewable integrates innovative engines which are particularly effective for analyzing and controlling distribution networks with renewable energy. GOLD for Renewable has the capability of assessing the impact of renewable energy on distribution systems in on-line and off-line modes. Control strategies for enhancing the system performance and reliability with growing integration of renewable energy are available in the suite.

Functionality examples of GOLD for Renewable Energy Management:

#### CDFLOW

Continuation Distribution Power Flow

#### ADC

Renewable Energy Available Delivery Capability (ADC) Assessment

#### Nomogram

Multi-Zone & Scenario ADC Assessment

#### ADC Enhance/Volt/VAR

ADC Enhancement with Volt/VAR Control

#### Daily Switching Management Tool

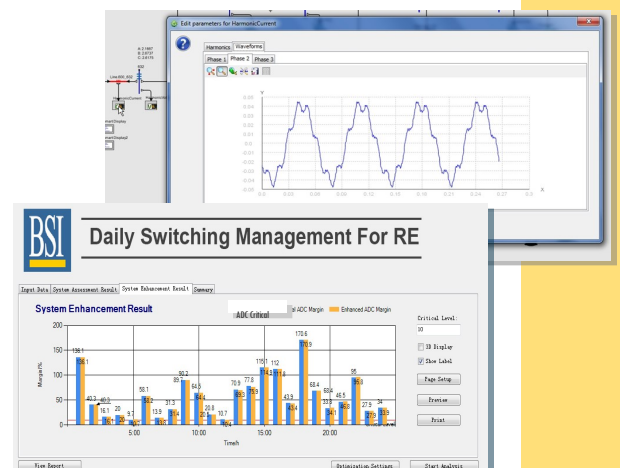
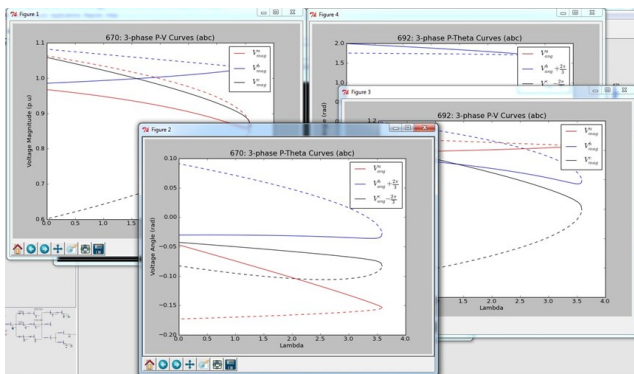
ADC Enhancement with Network Reconfiguration

#### Probabilistic Power Flow

Distribution Probabilistic Power Flow for Renewable Energy

#### Short-term Forecasting

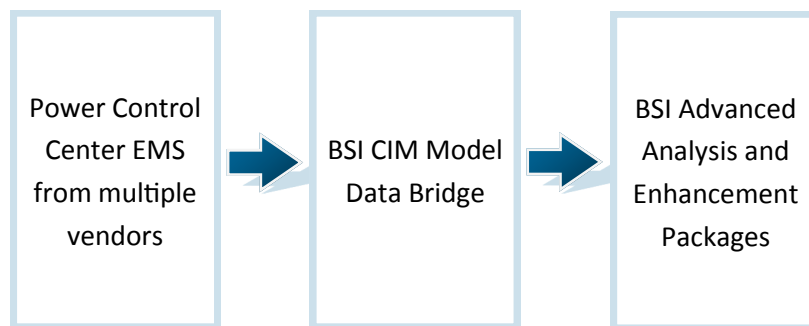
Short Term Load and Renewable Energy Forecasting



## Control Center Integration and Advanced Applications

### CIM Standards & Multiple EMS Vendor Experience

With our experience in control centers at major utilities such as PJM, CAISO and TVA, we have developed superior capability in handling node-breaker model transformation to bus-branch power flow solutions for on-line analysis. The CAISO EMS uses the BSI Data Bridge to convert CIM XML node-breaker file to a bus-branch format for all downstream advanced applications, including BSI's VSA&E systems and Powertech Labs' TSAT. The VSA&E system also interfaces with the CAISO Siemens Power Market System for stability analysis of Day-Ahead and Short Term Unit Commitment market dispatch.



### Multiple Vendors EMS Compatibility Capability

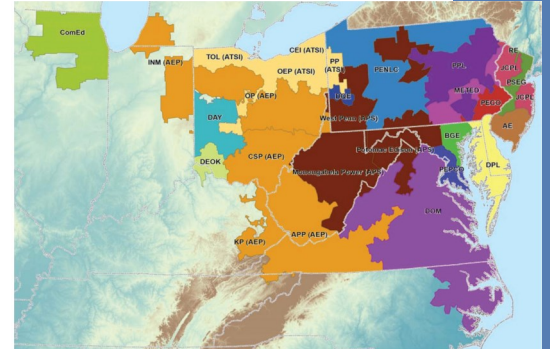
All BSI Advanced Analysis and Enhancement Packages interface with EMS environment from multiple vendors, such as ABB, ALSTOM and SIEMENS. The EMS database, state estimator snapshots, and dispatcher load flow files are made available to the BSI applications in a CIM/XML format. BSI package results, status and alarms are integrated in the Energy Control Center displays via the PI-Data Archive.

## PJM VSA&E Installation and On-line Application

In 2002 PJM issued an RFP in response to actual system conditions experienced during the summer of 1999. The PJM solicitation drew competitive proposals from several other vendors, including Alstom, Powertech, ABB, Siemens and PTI. PJM conducted extensive review of test study results submitted by all vendors. BSI results were found most valid as well as producing innovative and promising control recommendations. BSI was awarded the contract.

Integration with PJM Production EMS environment and modeling enhancements were completed in 2004. PJM continued to develop and enhance the VSA&E system contract with BSI to deliver requested enhancements in 2005 and 2006. BSI's on-line Voltage Stability Analysis and Enhancement tool has been operational since 2005 in the EMS control center at PJM Interconnection, Norristown, Pa. The system is widely used by the control center operators, reliability engineers, transmission planners and power market personnel.

PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia. Acting as a neutral, independent party, PJM operates a competitive wholesale electricity market and manages the high-voltage electricity grid to ensure reliability for more than 61 million people.



## California ISO Installation and On-line Production

In early 2007, CAISO Grid Operations felt a need to equip the control room floor operators with advanced tools for real-time assessment of voltage security of the grid. The senior executives included it in the Five Year Business Plan and earmarked the implementation of the Real-Time VSA tool in 2008.

The Network Applications department and the VSA implementation team at CAISO evaluated a large number of vendors. After narrowing the field down into two finalists, their EMS vendor and BSI, the vendor of choice was Bigwood Systems, Inc..

The Voltage Stability Analysis and Enhancement (VSA&E) is an essential tool for maintaining transmission grid reliability. The CAISO VSA&E implementation operates in six modes and includes many advanced capabilities such as, integration of renewable energy, CIM compliance, and Remedial Action Schemes (RAS) and Special Protection Systems (SPS) modeling and simulation of contingencies.



Real-Time (VSA&E/RT) provides real-time assessment of the Voltage Security of the system based on the current operation point state estimation. Look-Ahead (VSA&E/LA) provides a user friendly tool to give a quantitative view of where voltage problems exist ahead at a future point in time, the proximity of the system (system margin) operating point to the problem and what operations can be taken to steer the system into towards the secure operating regions. In addition, Study (VSA&E/Study) offers tools to assess the voltage security of any on-line case or planning case in a comprehensive study environment.

VSA&E enhancement and preventive control recommendations provide the system operators a set of operations that can be taken to steer the system into secure operating regions with increased load margins and avoid insecure next contingencies.

On-line VSA&E had been operational since 2008 in the CAISO control centers at Folsom, CA and Alhambra, CA. In 2010, CAISO took steps to provide ISO decision makers a longer forecast window that gives them time to identify long-term voltage issues and prevent voltage collapse by making a major enhancement to VSA&E. Two new VSA&E production lines were added, VSA&E Day-ahead (VSA&E/DA) to assess a forecast based on the hourly day-ahead information covering a 24-hour period and VSA&E Short-Term Unit Commitment (VSA&E/STUC) to assess a forecast based on 15-minute short-term unit commitment information covering a 4.5-hour period. VSA&E technology is now used corporate-wide by Grid Operations, Reliability Coordination, Regional Transmission Planning – North & South, EMS-IT, IT and the Network Applications. In 2013, BSI delivered VSA&E/Renewable to CAISO to meet the California challenge of 30% renewable energy by 2020.

**“BSI’S On-line VSA is simply the best in the field.”**

**— CAISO Project Manager**

**Bigwood Products Operating at CAISO:**

- ◆ VSA&E/RT: On-line Voltage Stability Analysis and Enhancement/ Real-Time
- ◆ VSA&E/LA: On-line Voltage Stability Analysis and Enhancement/ Look-Ahead
- ◆ VSA&E/Study: On-line Study Voltage Stability Analysis and Enhancement
- ◆ VSA&E/DA: On-line Voltage Stability Analysis and Enhancement/ Day Ahead
- ◆ VSA&E/STUC: On-line Voltage Stability Analysis and Enhancement/ Short Term Unit Commitment
- ◆ VSA&E/Renewable: On-line Voltage Stability Analysis and Enhancement/ Renewable



**California ISO**  
Shaping a Renewed Future



## Tennessee Valley Authority (TVA) On-line Implementation

BSI in cooperation with the Tennessee Valley Authority developed an On-line Var Management System (VMS) for regional reactive reserve monitoring and control. The TVA Regional VAR management system runs voltage stability under a full contingency list, monitors region VAR demand and calculates regional VAR capability of local and imported VAR resources using State Estimator snapshots.

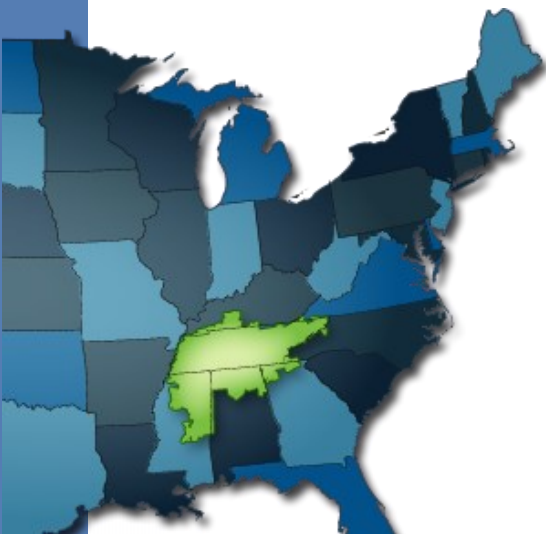
“The BSI VMS solution produced accurate results and immediate operational benefits like no other systems.”

— TVA Project Lead Engineer

The system began producing current status and alarms for the reactive reserves of the 15 reactive regions within the TVA control area in 2011. In subsequent months the system identified several issues with the TVA System not detected in any production system. The VMS detection and alarm allowed TVA engineers to verify the problem and take corrective action before the issue became real-time.

In 2012 the VMS was put in production in the TVA System Control Center. The reactive reserve management system is characterized by three key functional elements: (1) Situational awareness enhancement, (2) Alarm and visualization, (3) Corrective control.

Presently, TVA system operations are able to monitor quantities from the EMS system and produce accurate information for reactive reserve management in the critical reactive reserve regions. The system accuracy has eliminated the frequent false alarms previously raised by the EMS reactive reserve monitoring system. In addition, the system provides corrective control suggestions to eliminate VAR problems



## TEPCO Cooperation and TEPCO-BCU Package

Tokyo Electric Power Co. (TEPCO), the largest private electric utility in the world, has been working with BSI since 1997 to develop advanced tools for on-line power system monitoring, assessment and control in Energy Control Center.

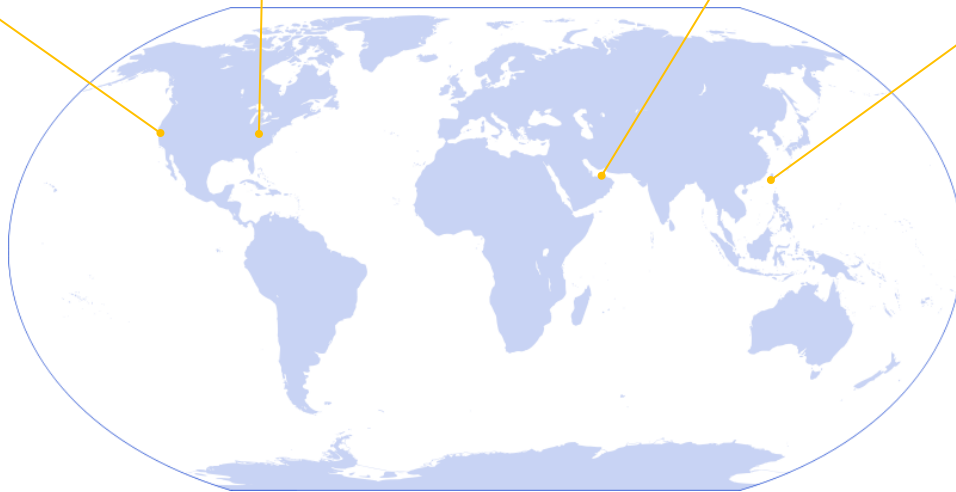
**TEPCO-BCU for On-line Transient Stability Analysis and Control** is an integrated package developed for fast yet exact transient stability assessments and control of large-scale power systems for the on-line mode, on-line study mode, or off-line planning mode. TEPCO-BCU is jointly developed, owned, supported, and marketed by TEPCO and Bigwood. It offers several significant engineering and financial benefits. This advantage leads to accurate utilization of transmission capacity and increased transmission capacity without additional transmission investment.

TEPCO-BCU is integrated with the Energy Management System of more than 10 large electric utilities in Asia, Central America and North America to perform on-line dynamic security assessment as a tightly coupled component of the Energy Management Control Center. TEPCO-BCU uses the most advanced methods including 5 patented methods to perform fast dynamic contingency screening, ranking, and control enhancement. In addition, TEPCO-BCU applies to system dynamic modeling, demand responses, and SPS designs, among others.





*Bring Power to Innovation!*



### **US Corporate Office**

35 Thornwood Drive, Suite 400,  
Ithaca, NY 14850, USA  
<http://www.bigwood-systems.com>  
[sales@bigwood-systems.com](mailto:sales@bigwood-systems.com)  
t: +1 (607) 257-0915  
f: +1 (607) 257-0237

### **Asia Office**

2F, No.58, Hsin Seng S. Rd., Sec.3,  
Taipei, Taiwan, R.O.C.  
<http://www.bigwood-systems.com>  
[sales@bigwood-systems.com](mailto:sales@bigwood-systems.com)  
t: +886 (2) 2362-5115  
f: +886 (2) 2362-5116

### **Silicon Valley Office**

8100 Jarvis Avenue,  
Newark, CA 94560, USA  
<http://www.bigwood-systems.com>  
[sales@bigwood-systems.com](mailto:sales@bigwood-systems.com)

### **Middle-East Office**

#### **EME Energy Solutions, LLC**

Office Suite #301  
Al Bateen Towers, C2 Building  
Bainuna Street, Abu Dhabi, UAE  
<http://www.eme-energy.com>