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From: Jerry D. Smith
To: DGI Interested Parties
Date: 12/7/99 11:19am
Subject: October 25 DGI Workgroup Meeting Minutes

(Reply by E-Mail if you desire to be removed from this distribution list)

As a party interested in the ACC's investigation of Distributed Generation and Interconnections you will find the following attached DGI Workgroup items:

1. October 25 Workgroup meeting minutes.
2. Guest Speaker- Scott Castelaz - presentation materials.

These items will be filed in ACC Docket Control per:
Docket No. E-00000A-99-0431
General investigation of Distributed Generation and Interconnections for potential retail electric competition rules consideration.

CC: LLK

Arizona Corporation Commission
DOCKETED

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DOCKETED BY

Special Open Meeting Minutes
Distributed Generation & Interconnections Workgroup

Date: October 25, 1999 **Time:** 10:00 A.M.

Place: Arizona Corporation Commission Hearing Rooms 1 & 2
1200 W. Washington St., Phoenix, AZ 85007

Purpose: The Arizona Corporation Commission (ACC) Utilities Division sponsored a special open meeting to report Distributed Generation & Interconnections (DGI) Workgroup progress.

Attendance:

- Arizona Corporation Commission (ACC): No quorum of Commissioners, Commission staff members
- City staff from Phoenix, Scottsdale, and Tucson
- Representatives of Arizona Utility Investors Association (AUIA), Distributed Energy Association of Arizona (DEAA), International Brotherhood of Electrical Workers (IBEW) and Residential Utility Consumers Office (RUCO)
- Representatives of ESPs / Utilities - APS, NEV, TEP, Sierra Southwest, SRP, SSVEC, and SW Gas
- Representatives of the following firms - Agra Simmons, Cummins Southwest, and Engine World

Summary: A guest speaker, Scott Castelaz of Encorp., gave a presentation entitled "Virtual Power Plant." His talk explained how new technology is being implemented in the utility industry to affect the deployment of Distributed Generation. A copy of his presentation is available in paper format or electronically via a PowerPoint presentation file. Mr. Castelaz advised that the US might benefit from looking at what Sweden, the United Kingdom and New Zeeland have done regarding distributed resources. Distributed Generation is already accommodated in these countries. In addition he suggested that IEEE interconnections standards will have a weak influence in our process because their development is progressing too slowly. He cited numerous US system experiences that serve as examples of why Distributed Generation is needed now to provide quick short-term solutions to system problems.

Each committee gave a status report regarding its assigned scope of work and associated workshop issues. A summary is provided below along with key issues raised by attendees.

Siting, Certification & Permitting Committee: This committee reported agencies and various local jurisdictional requirements already assume responsibility for air quality, fuel supply, noise and safety compliance. It is generally believed that application of most types of distributed generation technology will comply with such pre-existing requirements. Attendees raised a concern regarding differing requirements for different counties or local jurisdictions. For example Maricopa County is considering new special use permit language that addresses generating plants. Secondly, there was concern raised regarding the aggregate effects of locating

multiple units in a common geographical area. The committee was encouraged to explore the siting topic with other counties and municipalities not participating in the process.

Arizona OSHA representatives gave a presentation to this committee at its last meeting. OSHA's focus is on employers providing a safe working environment for their employees. OSHA Standard 1910.269 covers power generation, transmission, and distribution. It can be viewed at http://www.osha.gov. Installation, operation, maintenance, and repair of such utility components by qualified and trained personnel is a fundamental principal of OSHA standards. OSHA is not involved in residential settings; except in cases where the property owners' or resident's employees are involved. Some believe that training and instructions for operating a distributed generator may be the obligation of the manufacturer or party selling the equipment.

This committee's attention is now focused on considering two key processes. Future committee meetings will be devoted to considering a process for pre-certification of distributed generation systems and an application process for consumers desiring to install distributed generation technology. The informational content of these processes will be shaped by needs identified by the Access, Metering & Dispatch Committee and the Interconnection Standards Committee.

Access, Metering & Dispatch Committee: This committee began by conceptualizing different operational scenarios that could emerge from deployment of distributed generation. The committee's assigned workshop issues were then repackaged into two categories - tariff issues and operational issues. As a result this committee has organized into a tariff subcommittee and an operations subcommittee. This committee has conceptualized unit sizes into three groups for discussion purposes: less than 1 MW, 1-10 MW and greater than 10 MW. Whether a Utility Distribution Company has an obligation under the new Arizona Electric Competition rules to accommodate an interconnection for Distributed Generation purposes was raised by the audience. This committee has not yet reached a conclusion regarding this issue.

Interconnection Standards Committee: This committee has assembled and discussed existing and emerging national, industry and regulatory interconnection standards. It was concluded that most utilities in Arizona already have interconnection standards that accommodate qualifying facilities as defined by PURPA. APS, SRP and TEP agreed to develop and supply a draft interconnection document for committee consideration. The document has been provided and is a composite of the three utilities' interconnection standards with some negotiated modifications where there were significant differences. This committee is currently reviewing the draft document.

The Interconnection Standards committee has concluded that interconnection of distributed generators to the utility system utilizes three distinct technologies: inverter, synchronous generators, and induction generators. Based upon protection issues presented by application of these three distinct technologies this committee has grouped Distributed Generation into four classes: 50 kW or less, 51-300 kW, 301 kW - 5 MW and greater than 5 MW. Attendees questioned the choice of 300 kW as opposed to 500 kW for the breaking point between Class II and Class III. A request was made for additional inverter technology manufacturer representation on the committee. The new technologies are being UL and ETL type tested on an equipment

manufacturer basis. However, attendees raised concerns that complete systems were not currently being type tested.

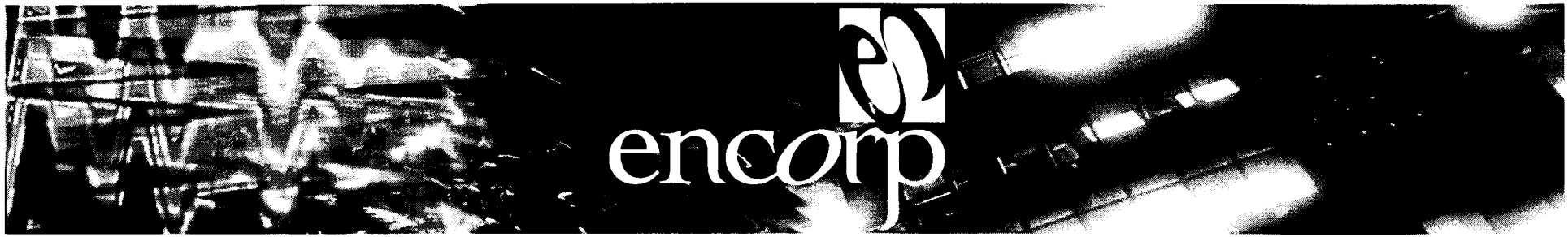
Meetings Adjourned at 12:10 PM

Recorded By: Jerry D. Smith, P.E., Utilities Division, Arizona Corporation Commission

Arizona Corporation Commission
Distributed Generation & Interconnection
Workgroup Meeting

The Business Case for the Virtual Power Plant

Phoenix, AZ - October 25, 1999



Scott A. Castelaz
Vice-President of Marketing & Corporate Development
Phone 312-945-3036 Email castelazsa@encorp.com

Why Are We Here?

To Discuss the Adoption of 'Smart Energy Technology' and Related Interconnection Policy Issues & Impacts

Why is This Important, You Ask?

1) **Spurs Industry Innovation to Value-Based Solutions**
2) **Increases Competition Among Suppliers**
3) **Enhances Customer Choice**
4) **Information - Based Technology will be the Foundation of the "New Energy Millennium" - IT is already becoming the basis for business in all of society**

The Internet Meets the Electron!

Agenda

- Overview of Virtual Power Plant (VPP) Market Drivers & Grid Interconnection Issues
- DER & the VPP as a Disruptive Technology
- The VPP Value Proposition
- Applications & Solutions

Watt's the Big Deal?

- Tales From the Dark Side - ***How's your Grid's Available Peak Capacity this Summer?***
- **Technology innovation + regulatory reform + customer choice are market drivers**
- **New Infrastructure for New Business Model**
- **Interconnection is a Barrier Whose Time Has Come - Birthing Process Without Learning Curve!**
- **Policy Activity on Geometric Rise**

Back to the Future?

- *"Almost every generally accepted view was once deemed eccentric or heretical."*

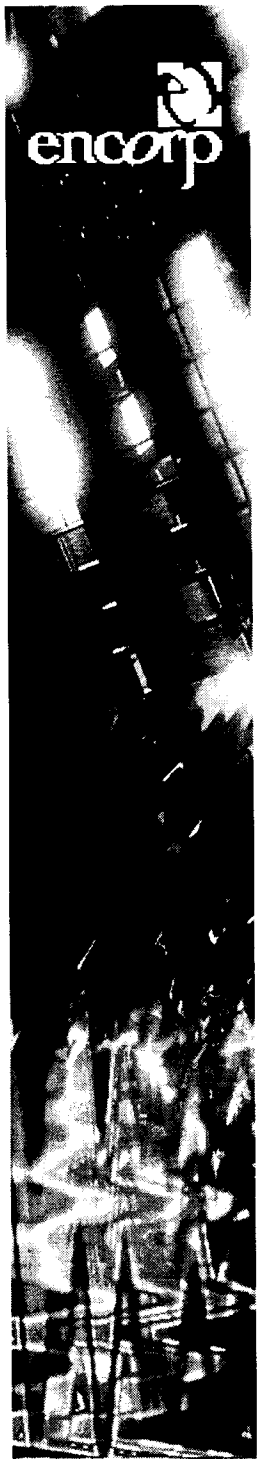
- Stephen Jay Gould, and other leading scholars

- *"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."*

- Physicist Max Planck, Scientific Autobiography and Other Papers

Other Brain - droppings:

- ***IBM & DEC on PC's: They're Just Toys!***
- ***Compaq acquisition of DEC: Are PC's driving the market now?***
- ***Conventional belief on FedEx: Who Wants Cheap Overnight?***



Today's Grid Characterization in North America:

- **One-way flow of electricity from source to end use, in general**
- **Central generation tied to local distribution islands**
- **Follows Laws of Physics better than Laws of Supply & Demand**

Commodity orientation, not value-focused or market-based allocation of T & D investment >> Leads to Under-utilization of assets & lack of true-cost basis to generate, transmit, & distribute electrons as well as ill-defined risk profile

- **Legacy IT systems throughout the grid, yet critical end-use information often not captured - by design**

Today's Energy Distribution to Customers

Transmission Line

Utility Distribution Substation

Utility or IPP

Growing Constraints with today's distribution systems

Distribution Line

Factories

Cities

Residential

Rural

DER's Future? - Total Energy Solution

Utility

Transmission lines

Substation

Substation Automation

Protective Relays

***en*telligent™ - VPP**
Owned, operated, and administered by end user wheeling power through T & D lines.

Customer #1

Customer #2

Customer #3

DER Interaction with Distribution Systems

- **Depends on Size, Location, & Type of DG**
- **3 Major Technical Interactions**
- **(1) Power Flow, & Capacity Changes that result**
- **(2) Voltage Level**
- **(3) Protection Needs**

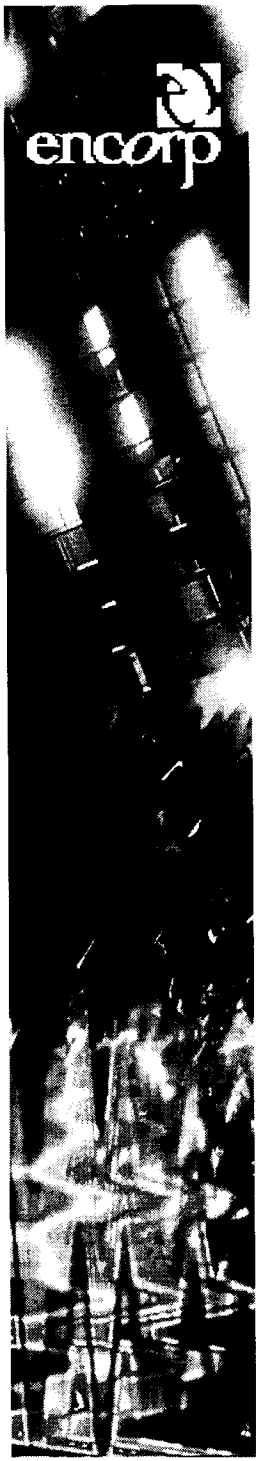
- *Not Uniform impact along the feeder - can be positive, negative, or none*

Specific Overriding Interconnection Issues

- **GIVENS: (1) Both DER Site and System Safety, and (2) Reliability MUST NOT BE Compromised**
- **(1) Power Quality, Reliability & Stability**
- **(2) Safety & Protection for personnel & equipment**

Basic Interconnection Equipment

- Power Transformer for generation source
- Metering
- Voltage Transformers for relays
- Visible Safety Disconnect Switch
- Communications for monitoring/dispatch
- Generator Circuit Breaker or Fused Switch
- Synchronism Check Relay (25)
- Over/Under Voltage Relay (27/59)
- Over Current Instantaneous, Inverse Time Relays (50/51, 50/51N)

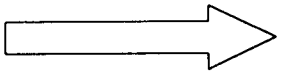


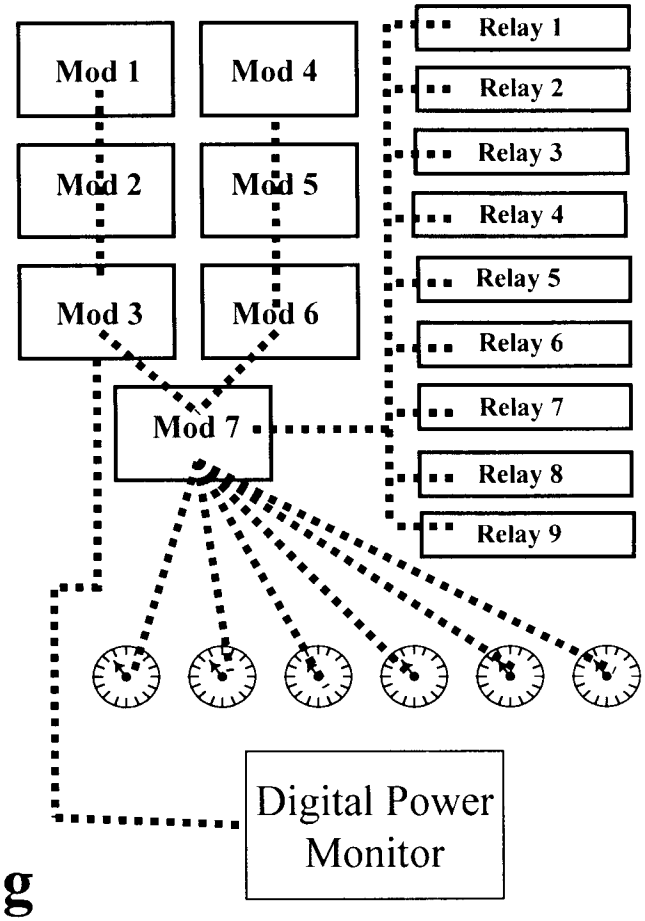
Additional Interconnection Requirements

- Over/Under Frequency Relay (81)
- Voltage - Restrained Over Current Relay (51V-R)
- Directional Power Relay (32)
- Impedance Relay with Timer (21)
- Transfer - Trip Transmitter/Receiver
- Approval from 3rd party or listing agency
- Design, Operation, & Installation Conformance to ANSI, IEEE, NFPA, NEC, IEC, etc

DER needs to be designed like a CAR, not like a Cathedral!

Traditional method



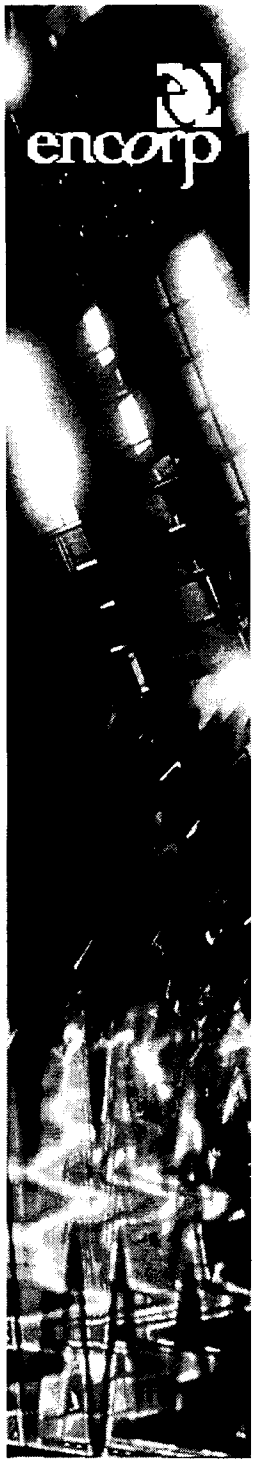


7 Control Modules

+ 9 Protective Relays

= 16 Different Modules
+ Analog Meters
+ Digital Power Monitor
+ Labor + Custom Engineering

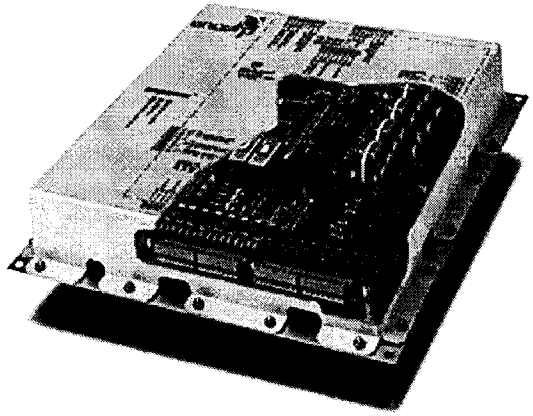
Too much custom labor, engineering time, panel space, and trouble-shooting makes this an unsuitable "wheel " for the "CAR"



A Fully Integrated Solution of Enabling Technology is Critical to DER's Growth

Power Metering

Local & Remote
PC Communications
Interface

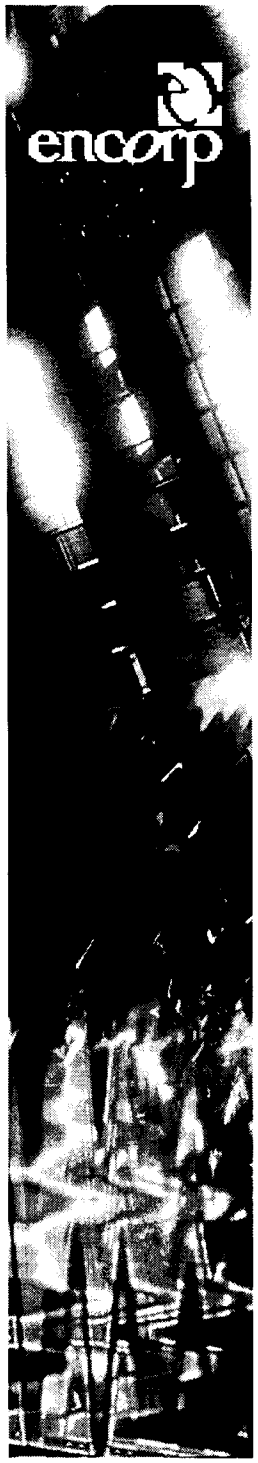


Generator
Control
Functions

Protective
Relays

Power Quality
Monitoring

Network Communications
for I/O Expandability



DER & Interconnection as a Disruptive Technology & Paradigm Shift

"It's about transforming today's radial, electromechanically controlled grid into an electronically controlled, open-access, smart network."

- EPRI President & CEO Kurt E. Yeager,

Source: S&P Utilities & Perspectives Research Report

DER & Interconnection as a Disruptive Technology & Paradigm Shift

"... we failed to anticipate the dramatic impact new technology had on our basis of competition ... and our ability to create value."

- CEO of AT&T, Robert Allen

Source: Analyst's Briefing

DER & Interconnection as a Disruptive Technology & Paradigm Shift

"First, disruptive products are simpler and cheaper; they generally promise lower margins, not greater profits. Second, (they) are first commercialized in emerging or insignificant markets. Third, leading firms' most profitable customers generally don't want, and indeed initially can't use, products based on disruptive technologies."

-Clayton M. Christensen, Professor at Harvard Business School

Source: The Innovator's Dilemma book

Utility Perspectives & Interconnection Approaches

- **"Standard Requirement" for an IOU is NOT the same as State - Level DG Interconnect Standard!**
- **Knowledge & Culture Create Understanding & Terminology Gap**
- **IOU/Regulator/Equipment Vendor Perspectives Are Inherently Different by their Perceived Roles in the Standard Development Process**

What criteria goes into a "standard?"

Obvious Criteria:

- **Hardware & Software Equipment**
- **Performance/ Conformance Tests**
- **Application/Functional Requirements**

But don't forget - "It's the PROCESS,STUPID!"

Standards are approximately 1/3 technical, 1/3 contractual/regulatory policy, 1/3 PROCESS TO APPROVE THE OTHER 2/3

How Goes The Interconnection Revolution?

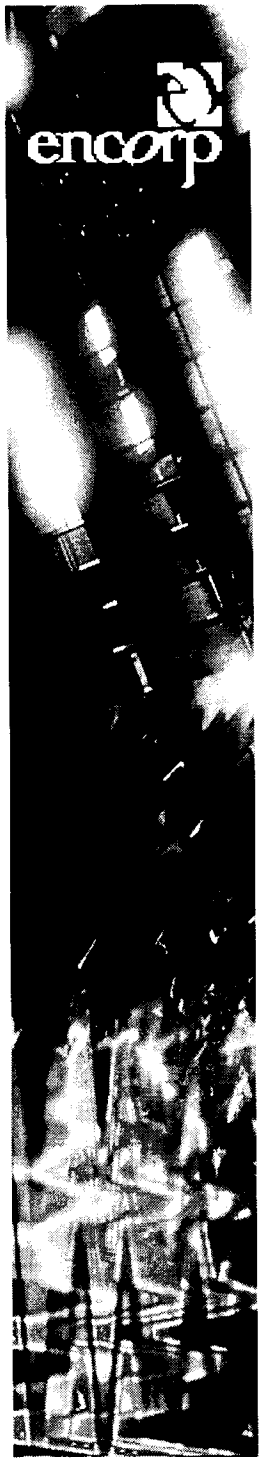
- **Often a case of 'Analysis Paralysis' by Castle Keepers**
- **We are all victims of the past!**
- **Inertia > Momentum: Why Change, We've been doing it this way forever?**

- **Big Policy Gap Exists between PURPA QF Cogen Standard and "DG Energy Appliance"**

- **DER Still mostly a "Hobbyist" or Early Adopter Market(i.e. - it's 1978 in PC time) without a "Killer App"(i.e. - spreadsheet software in PC talk) - Just Kinks in the Armor**

Interconnection Implications For DER Market At Present?

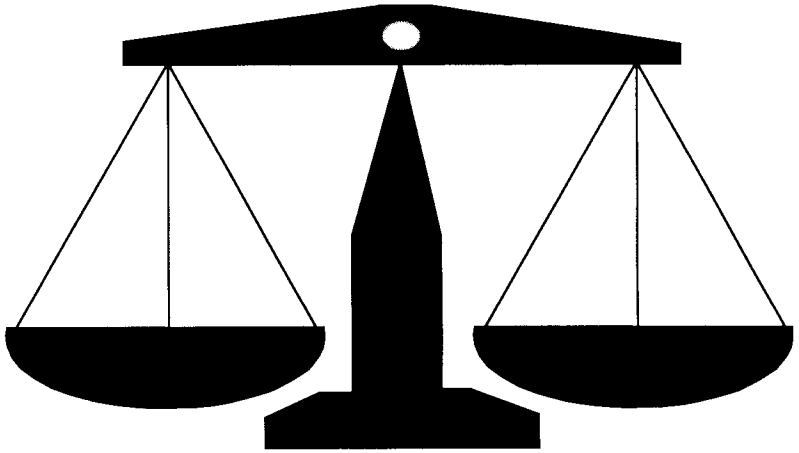
- **Local "Dial Tone", not National or even State-Wide Transparency!**
- **50 Roadmaps categorized by DG technology class (Inverter, Synchronous) and jurisdiction: Texas Fuel Cells, Calif ITG's, NY Gensets!**



Emerging IEEE Standards

- Significant Consensus Building Leverage
- Major Effort - SCC21
- Working Groups Established at Palo Alto meeting hosted by EPRI
- Unify Over 12 Existing Guidelines Into New Standard
- Meetings every 2 months for 2 years

Regulatory Policy Issues



Level the Balance so DG can compete on a Fair Basis

Regulatory Policy Issues

- **Removal of arbitrariness, replace by predictability& on equitable basis**
- **Technical & Contractual Reform**
- **Guidelines at minimum in near term to allow DG market a real chance**
- **Update the PURPA - vintage standards from merchant IPP to DG**

Policy Must Change With New Learning & New Technology

Virtual Power Plant Technology is the Key to Unlocking the Value

- Automated Aggregation Solution
- Remote Monitoring & Control
- Real-Time Economic Dispatch
- Hardware & Software Technology
- All DER Technology Applications
- Peak, Base, or Standby Capacity Use
- Utility, ESCO, Power Marketer, Load Aggregator, or End-User Markets
- Least - cost peak capacity solution

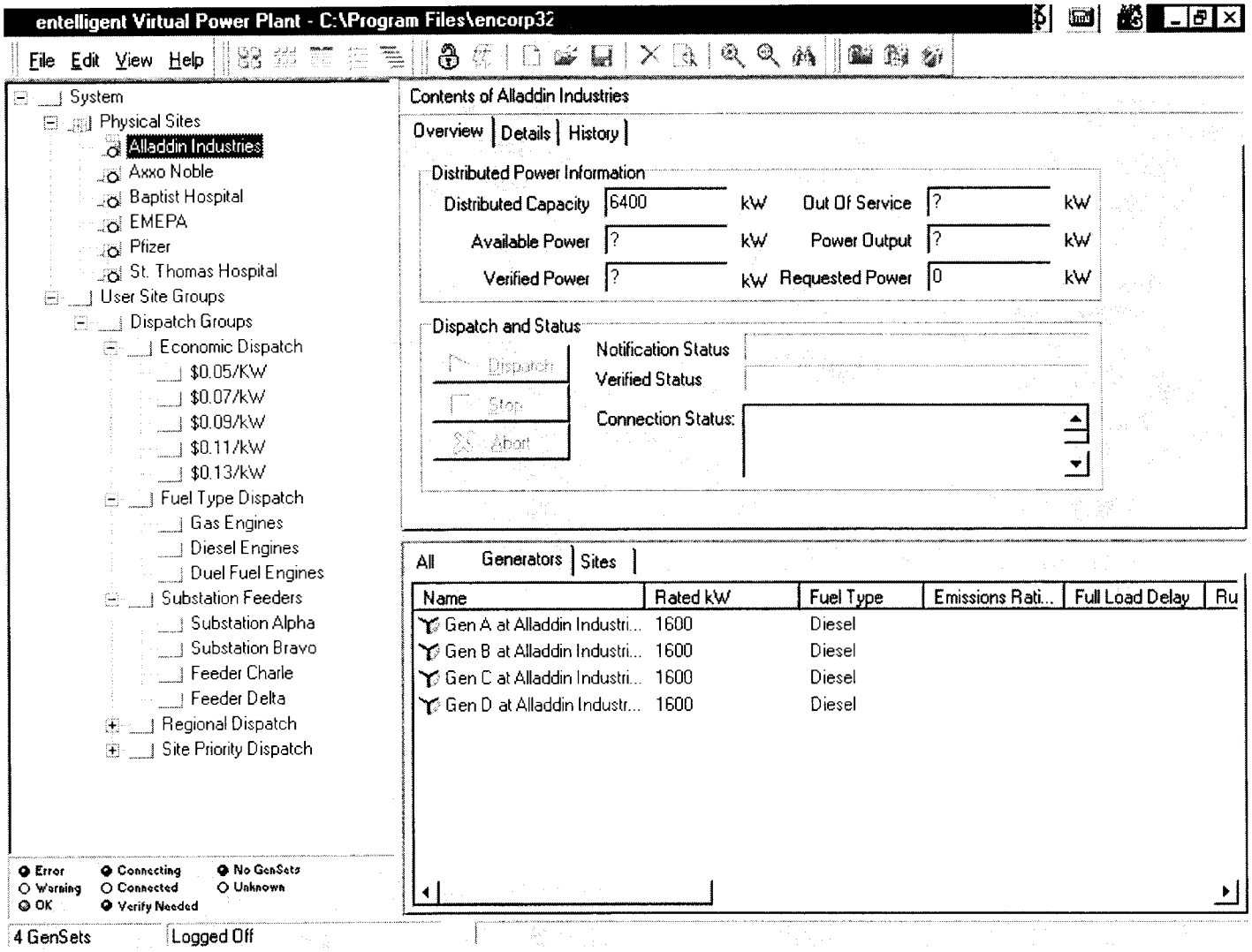
*en*telligent-VMM & VPP
Virtual Maintenance Monitor
Virtual Power Plant

Example screen-shots

ENERGY AUTOMATION TOOLS

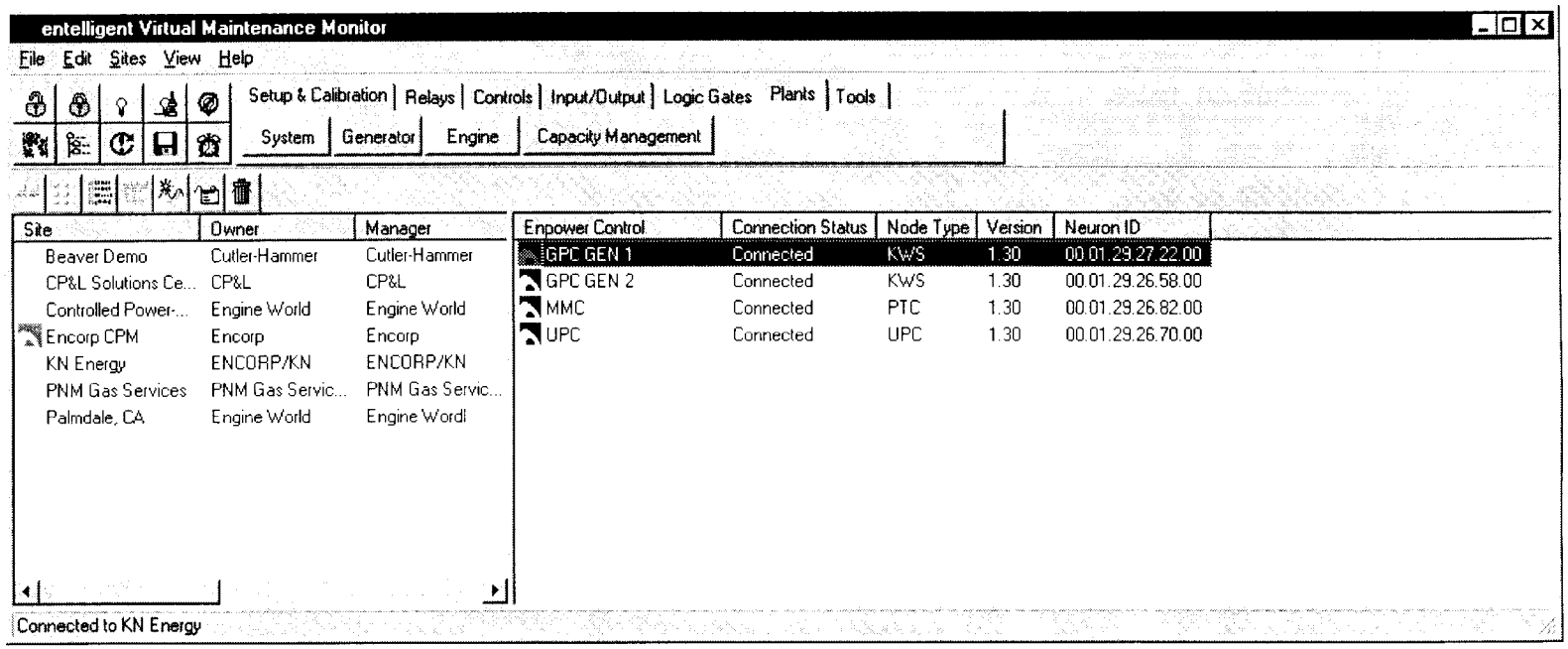
ENCORP ENABLED™

*en*telligent-VPP Navigation Screen



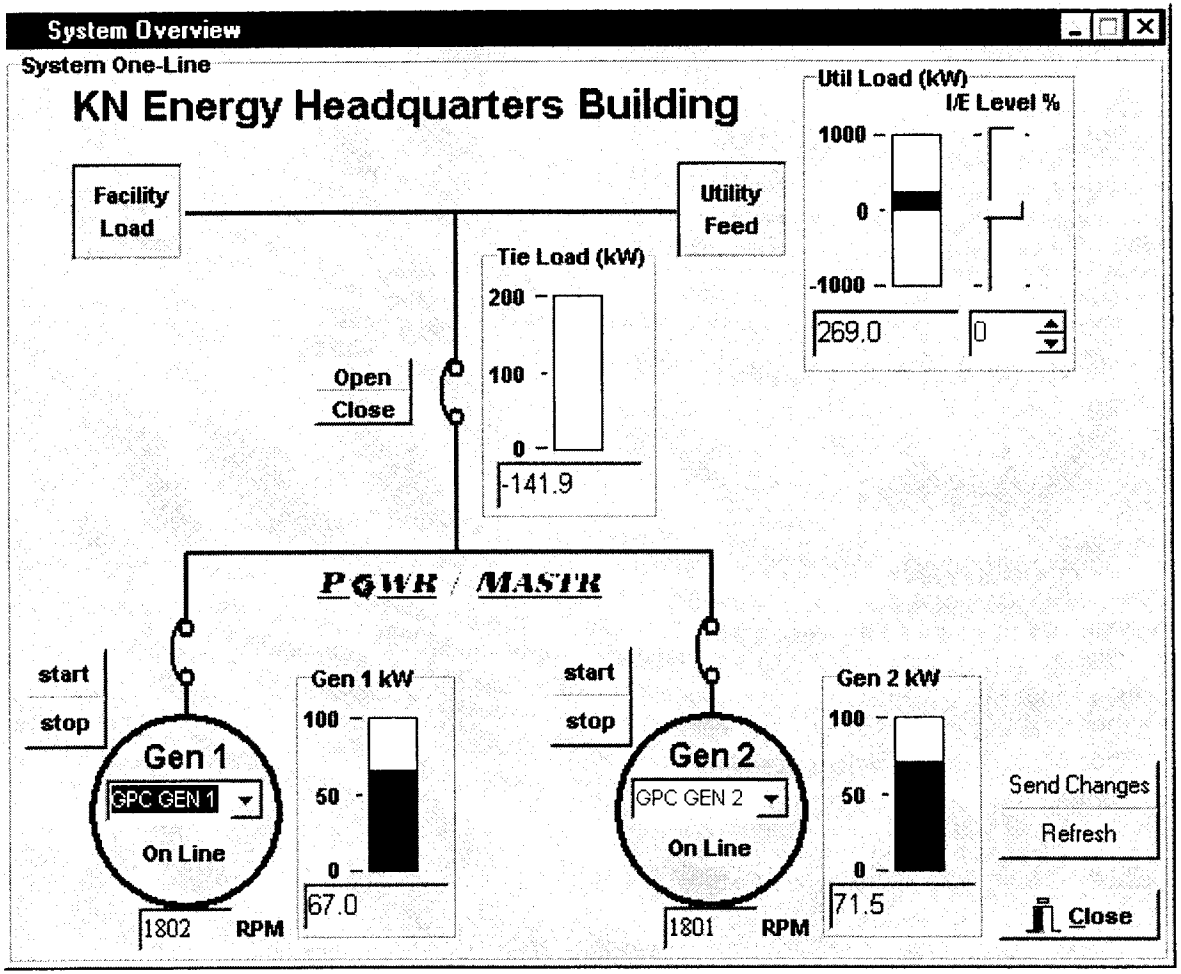
This screen creates a customized, economically optimized capacity solution for remote dispatch and real-time wholesale trading of multiple distributed energy resource sites. Groups can be defined by customer site, substation/grid location, fuel type, generation size, emissions levels, utility rates, and variable O&M cost.

*en*telligent-VMM Navigation Screen

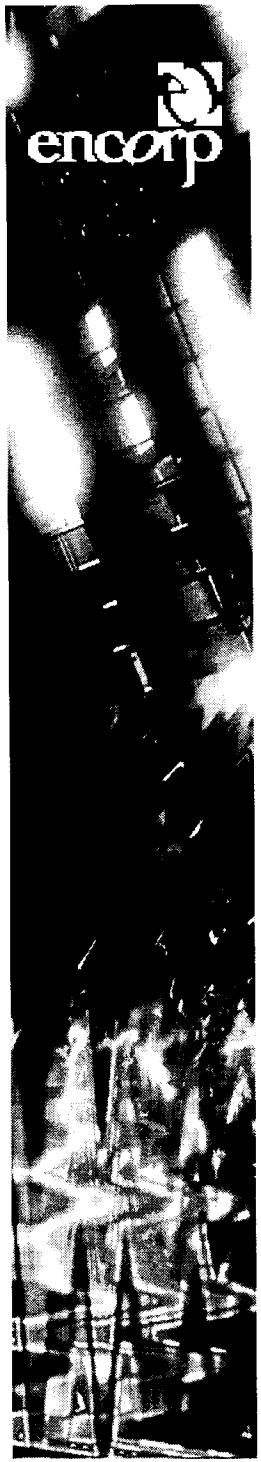


This screen is used for general navigation and site connection to single or multiple distributed energy resource (DER) site(s).

System Overview Screen



This screen shows a 1-line diagram of the currently selected DER site. Includes breaker status, generator sequence, building load and generator output. Stop/start commands are available from this screen.



Generator Overview Screen

Generator Overview

Node: UPC

PHASE SELECT

3Ø Totals / Averages

Voltage	482.09
Current	526.12
kW	-142.33
kVA	146.92
kVAR	2.91
PFactor	0.971 Lag
3Ø Hz	60.00
1Ø Hz	60.00

Voltage: 100 200 300 400 0 500 — 481.85

Amps: 120 240 360 480 0 600 — 519.30

kiloWatts: 60 120 180 240 300 — -142.12

Power Factor: 0.70 0.90 0.90 0.70 LAG (+) LEAD (-) 0.50 0.50 — 0.971

Breakers/Relays

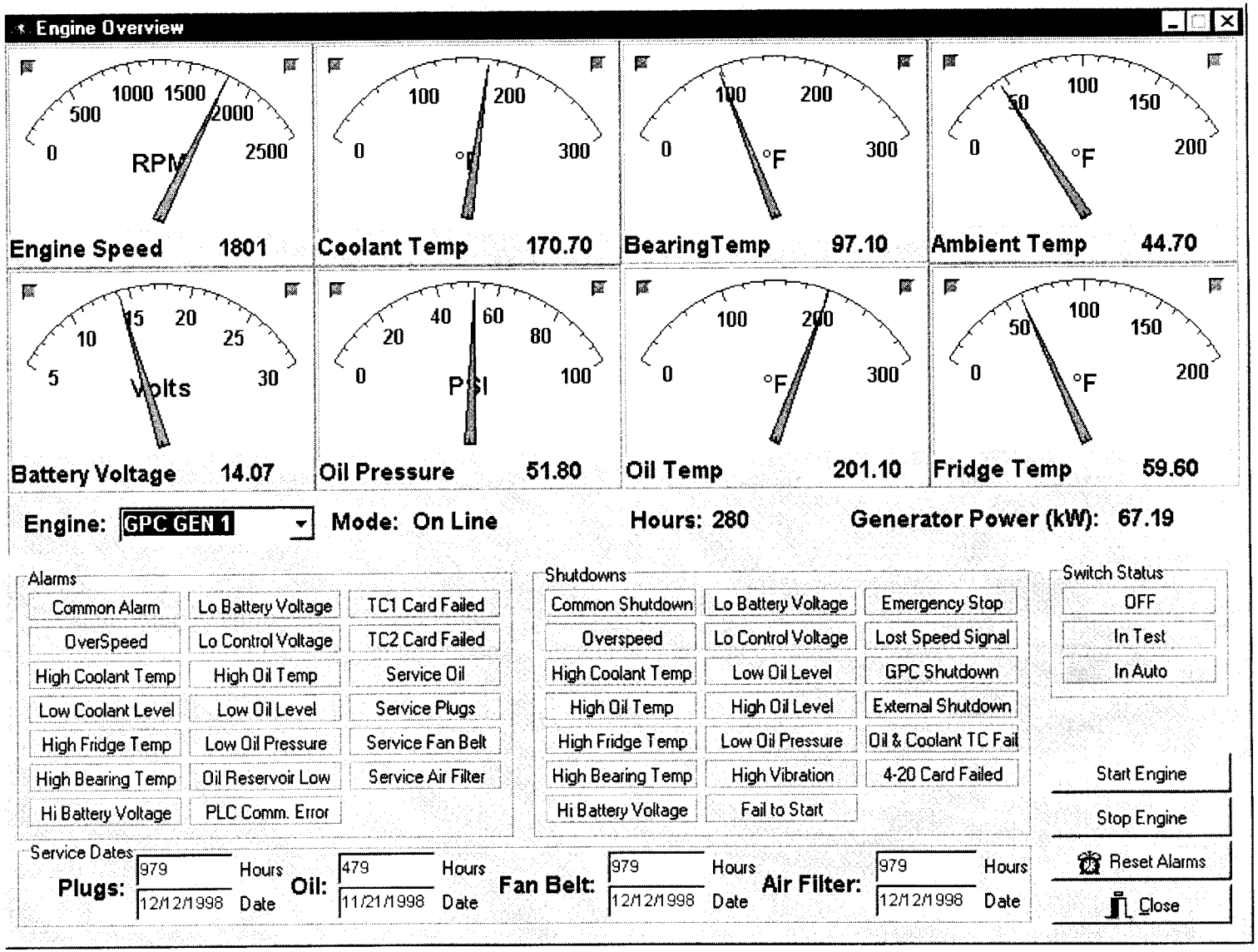
Gen Breaker Open	
27	59
81U	81O
32 Rev	32 Over
47N	46N

Close

getting data

This screen shows the current generator information including voltage, current, kW, power factor and protective relay status. The user may select individual or total phase metering.

Engine Overview Screen



This screen shows current engine information, alarm & shutdown conditions, and maintenance & operation information.

Capacity Management Setup Screen

Capacity Management Setup

Start Order

Generator	by RunTime	Participate	Swing
GPC GEN 1	TRUE	TRUE	FALSE
GPC GEN 2	TRUE	TRUE	FALSE

Move Up | Move Down | by RunTime | Participate | Swing

Capacity Management Setup Graph

Load (kW) 150 100 50 0

Time

Utility Load (kW) | Stop Generator | Start Generator

UPC BaseLoad Schedule

Weekdays 7:30:00 AM 4:30:00 PM

Saturday 12:00:00 AM 12:00:00 AM

Sunday 12:00:00 AM 12:00:00 AM

UPC Import/Export Schedule

Weekdays 12:00:00 AM 12:00:00 AM

Saturday 12:00:00 AM 12:00:00 AM

Sunday 12:00:00 AM 12:00:00 AM

Demand Limit Setup

Metering Node: MMC

UPC Node: UPC

Stop/Start Delay (secs): 60

Utility Load Variable: oTP__W____3

Utility Load Limit: 0.0

Hysterisis: 75.0

Current Demand (kW): 263

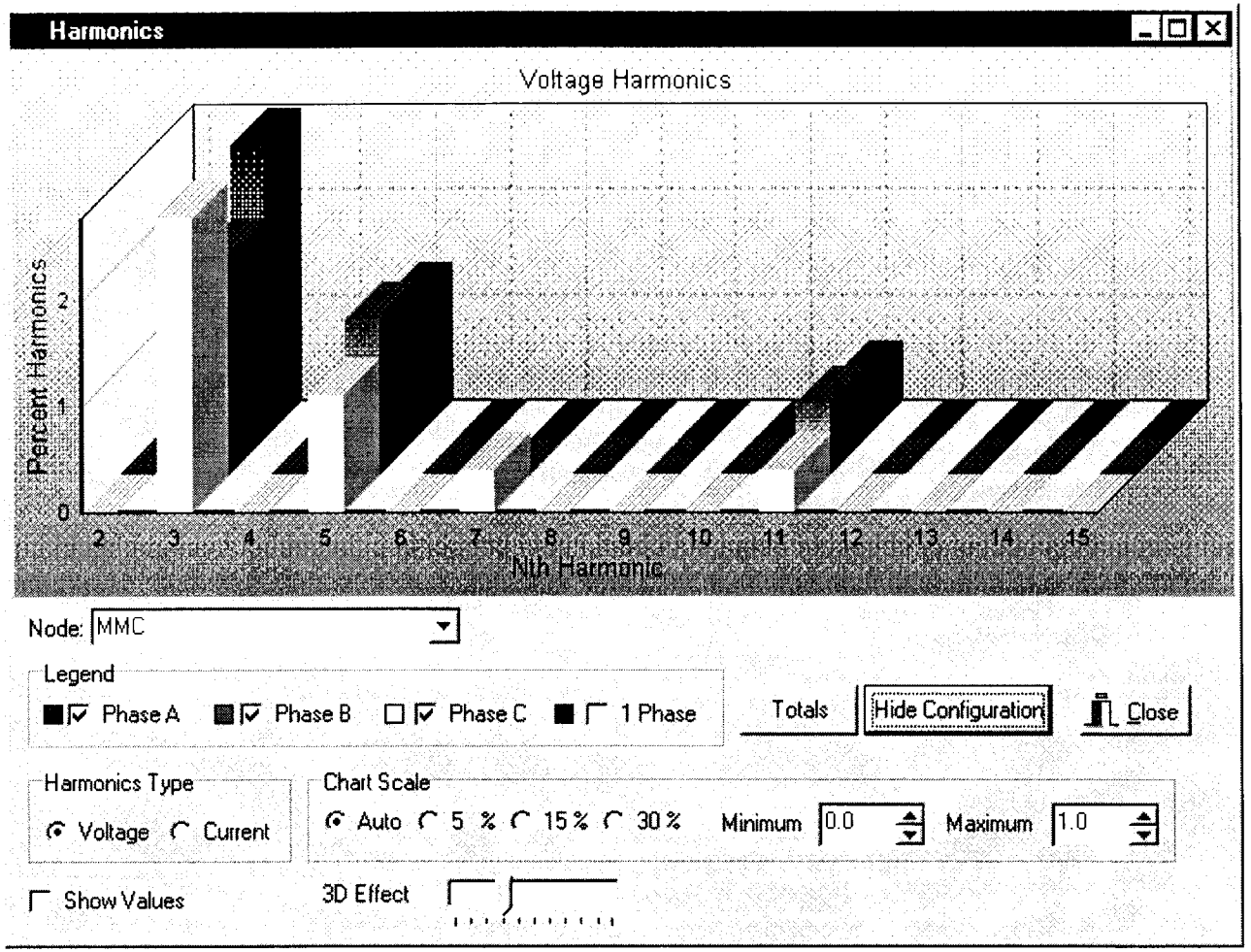
GPC BaseLoad Variable: iNAO_In_3A_

UPC Import/Export Variable: iKWC_EnPC__

Apply | OK | Cancel

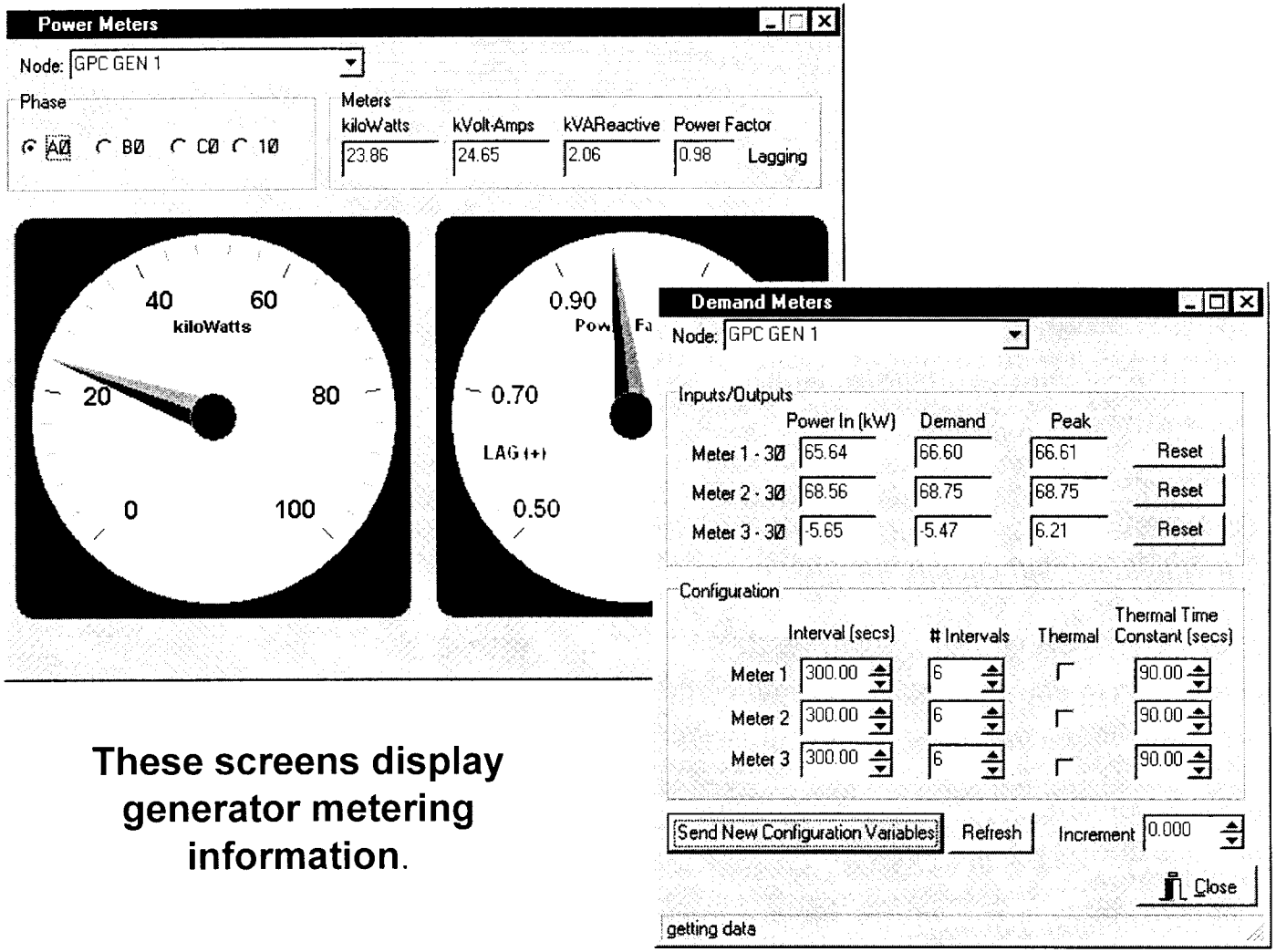
This screen allows the user to perform automatic capacity mgt based on the time of day, days operated and/or building load level.

Harmonics Screen



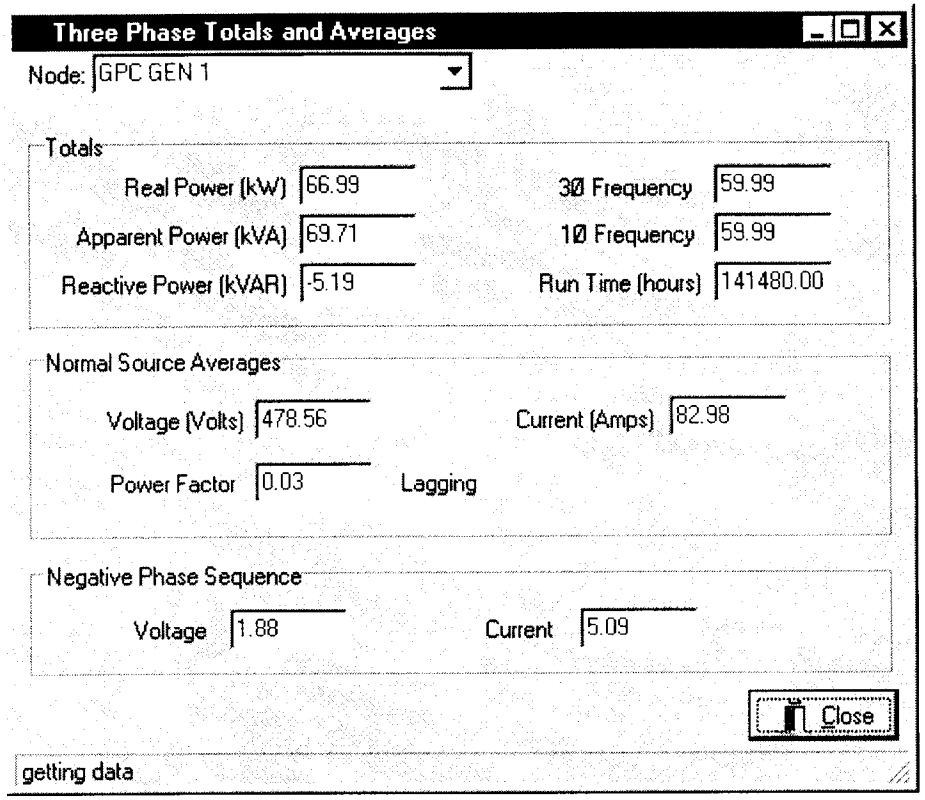
This screen displays harmonics for power quality monitoring purposes, and may display either voltage or current - up to the 15th harmonic.

Demand/Power Meters



These screens display generator metering information.

Power Display Screen



This screen shows current 3-phase Totals and Averages for selected real power (kW), apparent power (kVA) and reactive power (kVAR).

Annunciator Screen

Annunciator #1

Node: GPC GEN 1 | Configuration Cross Over List: 1 - Latched

Inputs, Outputs, and Configurations

Annunciator #1	Annunciator #2	Annunciator #3	Annunciator #4
Input / Output	Input / Output	Input / Output	Input / Output
Configuration: 1	Configuration: 1	Configuration: 1	Configuration: 1
Annunciator #5	**Annunciator #6**	**Annunciator #7**	**Annunciator #8**
Input / Output	Input / Output	Input / Output	Input / Output
Configuration: 1	Configuration: 1	Configuration: 1	Configuration: 1
Annunciator #9	**Annunciator #10**	**Annunciator #11**	**Annunciator #12**
Input / Output	Input / Output	Input / Output	Input / Output
Configuration: 1	Configuration: 1	Configuration: 1	Configuration: 1
Annunciator #13	**Annunciator #14**	**Annunciator #15**	**Annunciator #16**
Input / Output	Input / Output	Input / Output	Input / Output
Configuration: 1	Configuration: 1	Configuration: 1	Configuration: 1

Audible Ouput | Visual Output | Lamp Test Input | Acknowledge Input | Reset Input

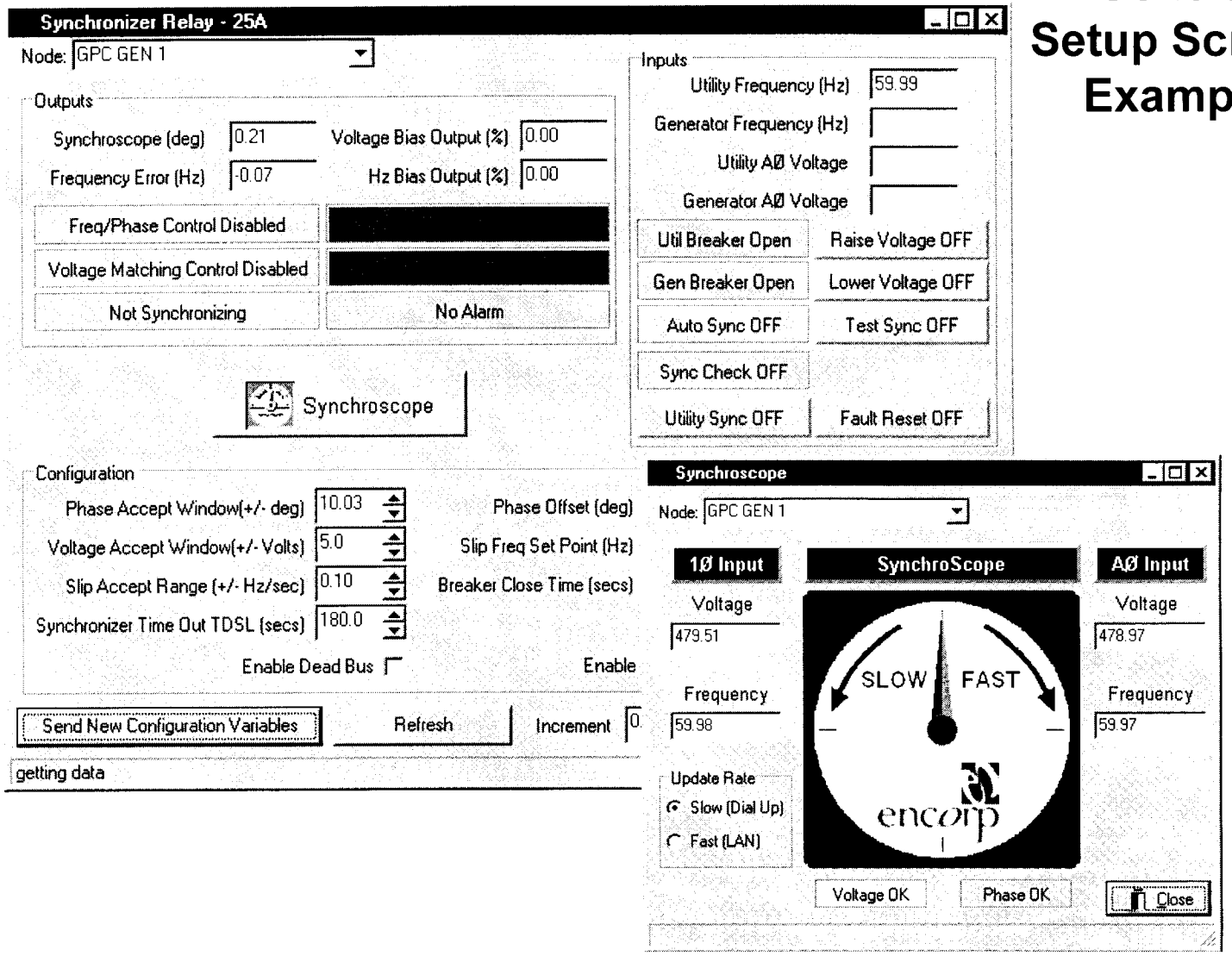
Maximum Send Time: 10.0 | Minimum Send Time: 10.0 | Flashing ON / OFF Time: 1.0

Send New Configuration Variables | Refresh | 0.00 | Close

getting data

This screen displays alarms and shutdown information and can record and store variables monitored on the *en*power products.

Control Setup Screen Example



These screens allow the user to configure the synchronizing control, and to monitor the synchroscope during setup.

Control Setup Screen Example

Reactive Demand Sharing and VAR/PF Control

Node: GPC GEN 1

Inputs

Gen Reactive Load (kVAR)	-7.62	Power Factor Setpoint	1.00 Lead
Gen Power Factor	0.96 Lead	kVAR Setpoint	0.00
Gen Average Voltage (V)	119.67	kW Sharing Ratio	0.91
Voltage Bias Input (%)	0.00	BaseLoad Ratio	1.00

Generator Aux | Utility Aux | PF Ctrl Selected | Remote Disabled

Remote Setpoints (%)

#1 0.00 #2 0.00 #3 0.00 #4 0.00

Remote Voltage Bias Inputs (%)

#1 0.00 #2 0.00 #3 0.00 #4 0.00

Reactive Load Sharing Inputs from other Generators

Outputs

VAR Output (%)	0.02
Voltage Bias Output (%)	-8.69
Gen PF Setpoint	0.90 Lag
Gen kVAR Setpoint	0.00

Reactive Power Control Limit

Reactive Power Control Fault

Reactive Power Control Mode

In Utility Parallel

Configuration/Calibration

Reactive Power(kVAR)	100.0	Voltage Trim Ki	0.100
Average Voltage (V)	465.0	Voltage Trim Deadband	4.800
kVAR Setpoint (kVAR)	5.0	Power Factor Setpoint	0.90 (•) Lag ( ) Lead

VAR Control Setup

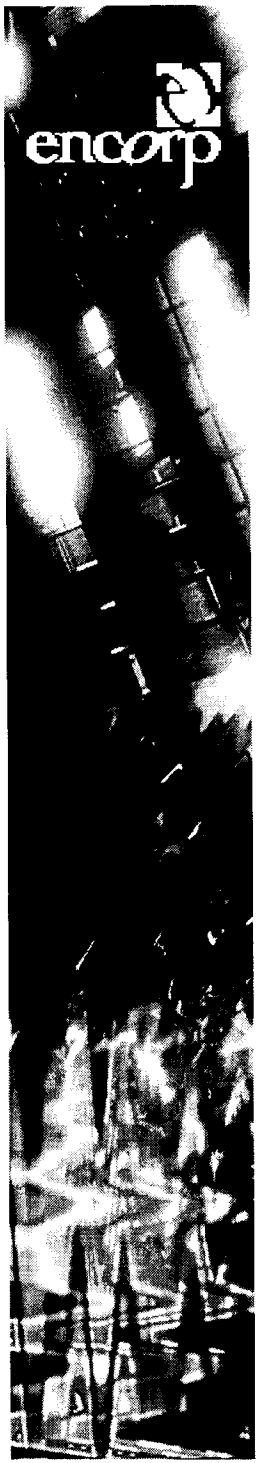
Power Factor Control Setup

Reactive Demand Sharing Control Setup

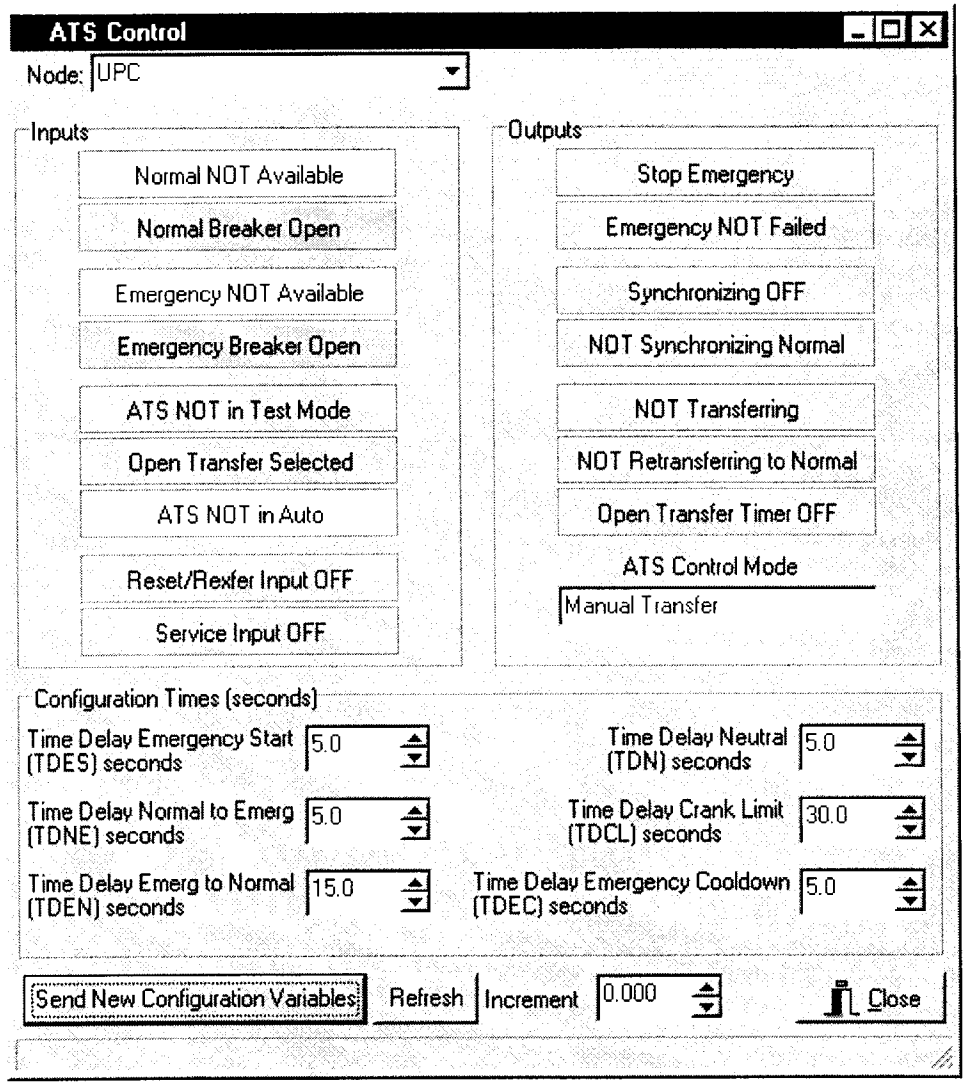
Reactive Power Control Fault Setup

Send New Configuration Variables | Refresh | Increment 0.000 | Close

This screen is used to setup and monitor the reactive demand sharing and VAR/PF controls.

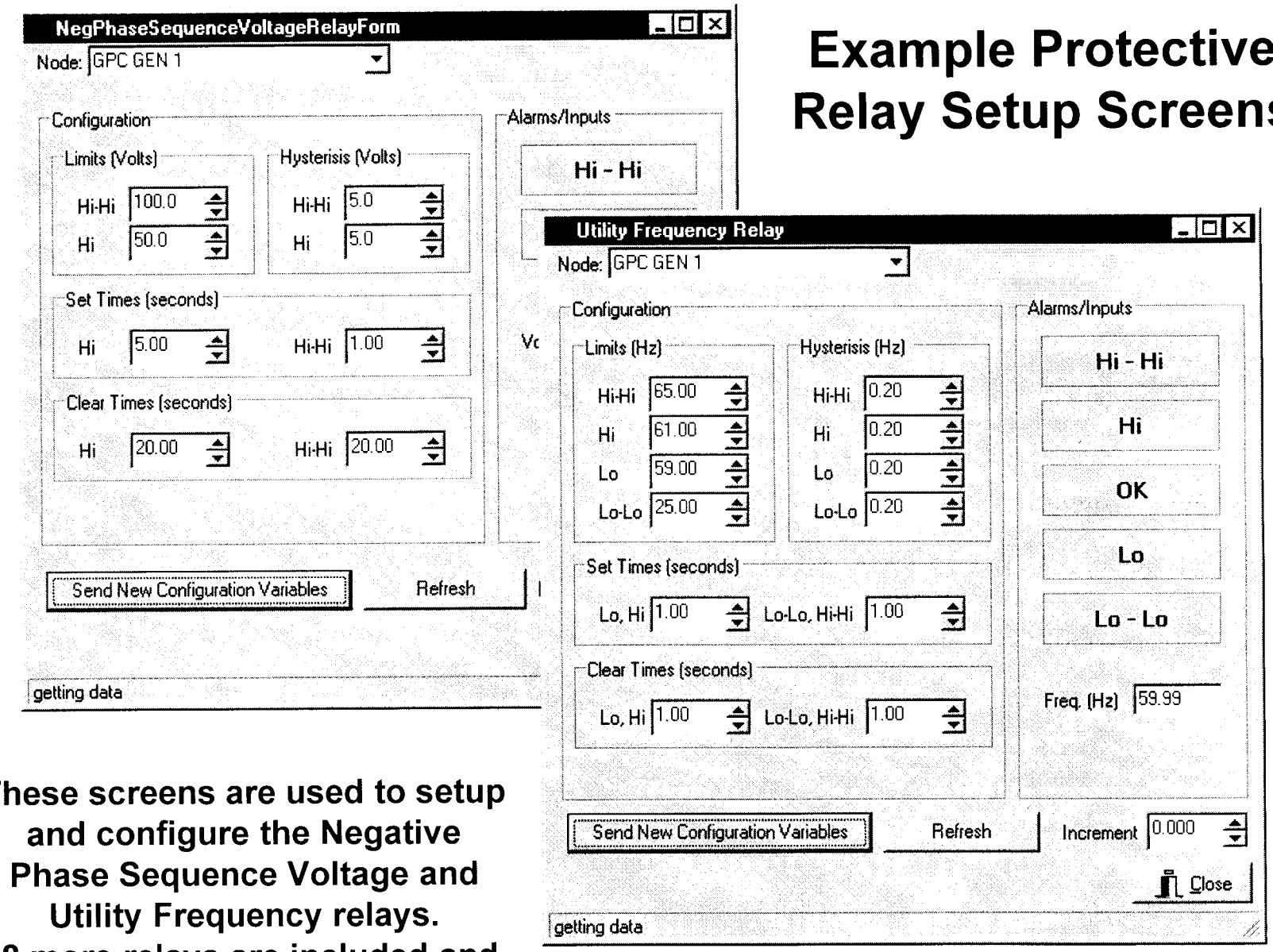


Control Setup Screen Example



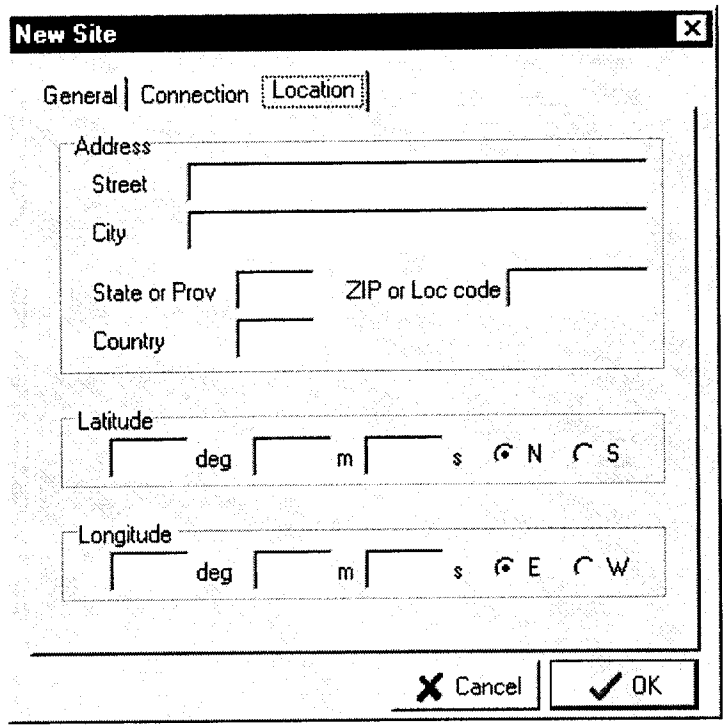
This screen is used to setup and monitor the Automatic Transfer Control.

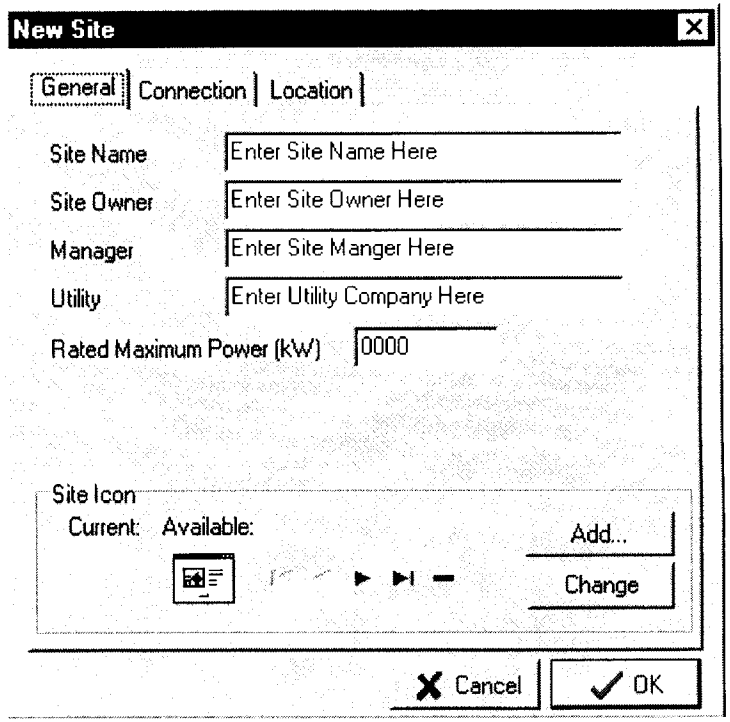
Example Protective Relay Setup Screens



These screens are used to setup and configure the Negative Phase Sequence Voltage and Utility Frequency relays. (8 more relays are included and configurable as shown here .)

Generation Site Properties Screens





These screens are used to setup and configure new distributed generation sites.

Command, Control, Communications and Grid Interconnection of Distributed Energy Resources - *What's Needed*

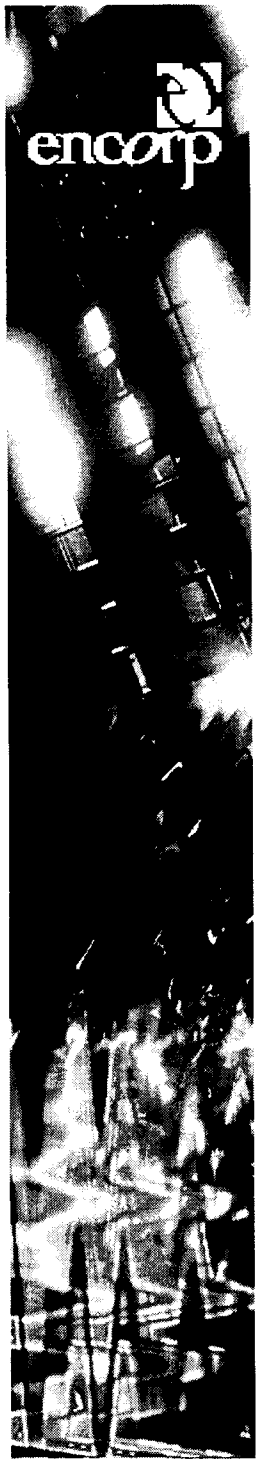
- **Mix of control, automation, protection and communication capability to interconnect**
- **Enabling technology that provides "Interconnection in a Box" - shrink the size, cost**
- **Scalable, flexible, intuitive, modular device = microprocessor + artificial intelligence algorithms + open protocol**
- **Technology Neutral Operation & Interconnection - Leverage across the DG technology range**

Automation Considerations for your DER or Micro-Grid Applications

- **Product that address different rate structures**
  - **Real-time pricing, Time-of-use pricing, Coincident demand rates, Interruptible rates**
- **Controls that work with a variety of existing engines, generators, switchgear & PLC equipment, as well as Emerging DER Technology such as Micro-turbines, Fuel cells, PV,etc**
- **System functionality to address peak sharing, base load, import/export control, automatic transfer, open & close transition, soft loading & unloading of power**
- **Controls that communicate using current & future communication media**
  - **Telephone, Cellular, Internet, Microwave, Radio, Satellite**

What other technology is needed to interconnect and perform more advanced applications?

- External "system -level" control to integrate multiple fuel cells, and/or other DG units to one another and the grid >
- Master Gateway Device - really a router/bridge communication, plus some embedded intelligence



The ANSWER?
The *en*power - RTU

- An adaptation of *EN*CORP's proven hardware product that further leverages the VPP solution
- Provides a cost-effective optimized solution for small (30-200kw) & inverter-based DER
- Tailored for Micro-turbines, Fuel Cells, Wind Power, & Hybrid Power Systems
- For economic optimization of single unit/site or aggregated DER assets
- 'Plug & Play' operations & maintenance capability
- Interface to the UDC, PX, or ISO for 'roll-up' of hundreds of DER into a Virtual Power Plant

Tomorrow's Market - A Brave New World?

- **More choices?** **Same "Dial Tone" for all DG across the US?**

- **End - to - End Value -Based Customer Solutions: Sell the benefit of the technology, not the technology itself!**

- **Mass - Customization for All: McD's meets Thomas Edison**

- **Energy Appliances?**

- *DG will be a physical & financial play, due to enabling Info Tech which will provide neural networks, genetic-based control algorithms, and enterprise level middleware for bulk-level optimization of the electricity Supply & Demand, and "omni-directional" power flow, in response to spot/future power market signals*