

**Arizona Corporation Commission  
Distributed Generation & Interconnection  
Workgroup Meeting**

***The Business Case for the Virtual Power Plant***

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**Scott A. Castelaz**

**Vice-President of Marketing & Corporate Development**

Phone 312-945-3036 Email [castelazsa@encorp.com](mailto: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?*

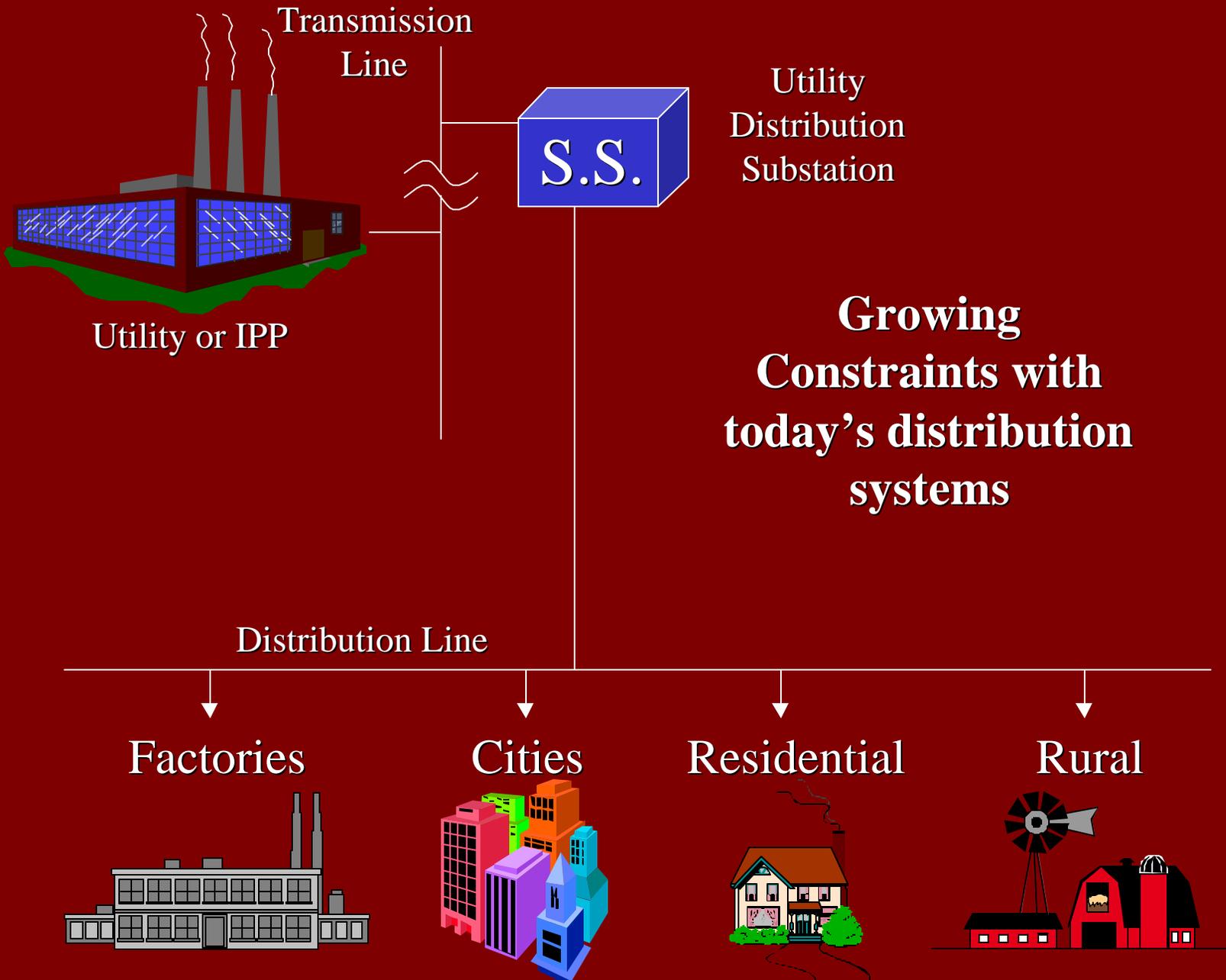
## Today's Grid Characterization in North America:

- 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*

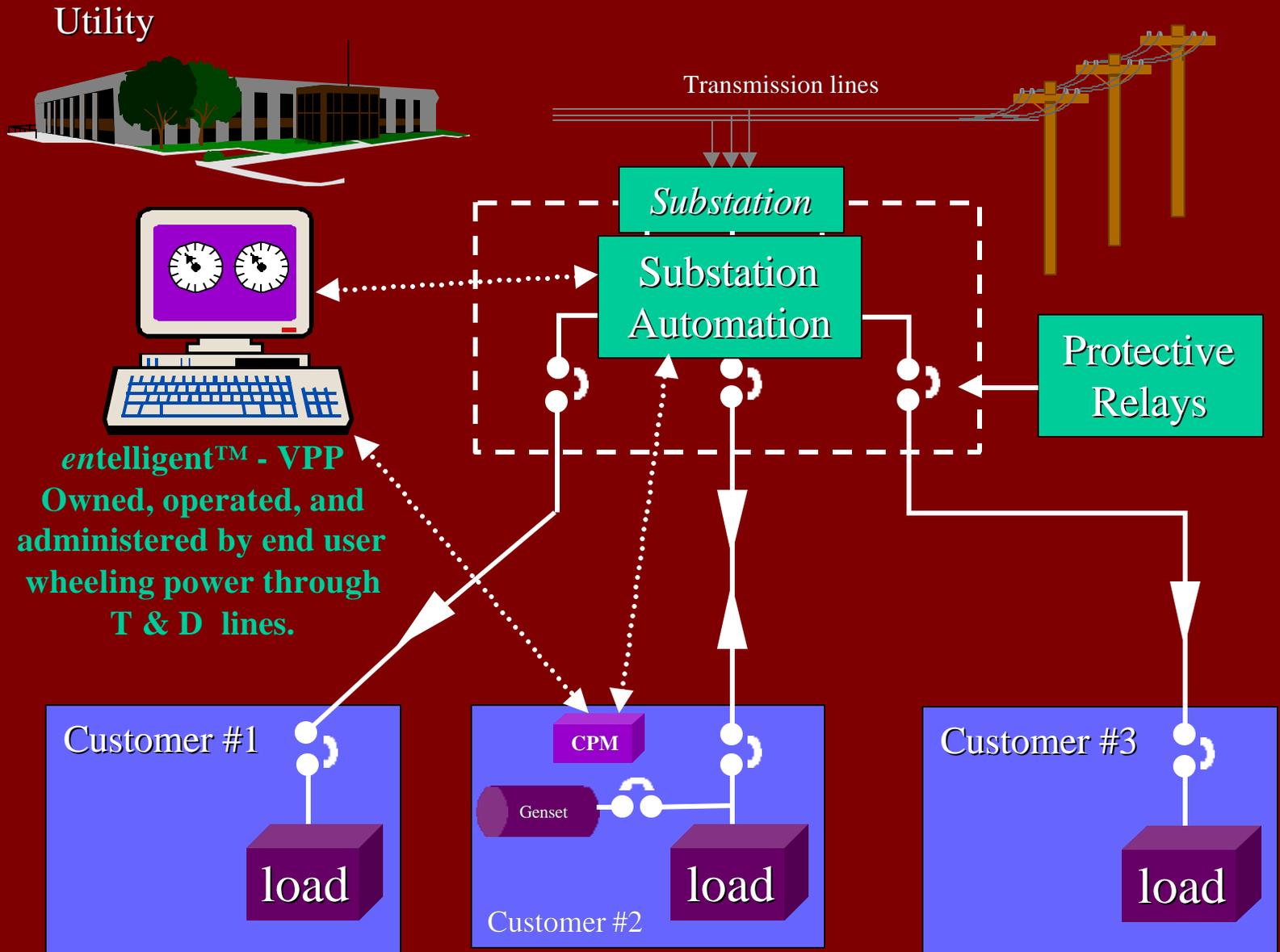
- Legacy IT systems throughout the grid, yet critical end-use information often not captured - by design

# Today's Energy Distribution to Customers





# DER's Future? - Total Energy Solution



## 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!

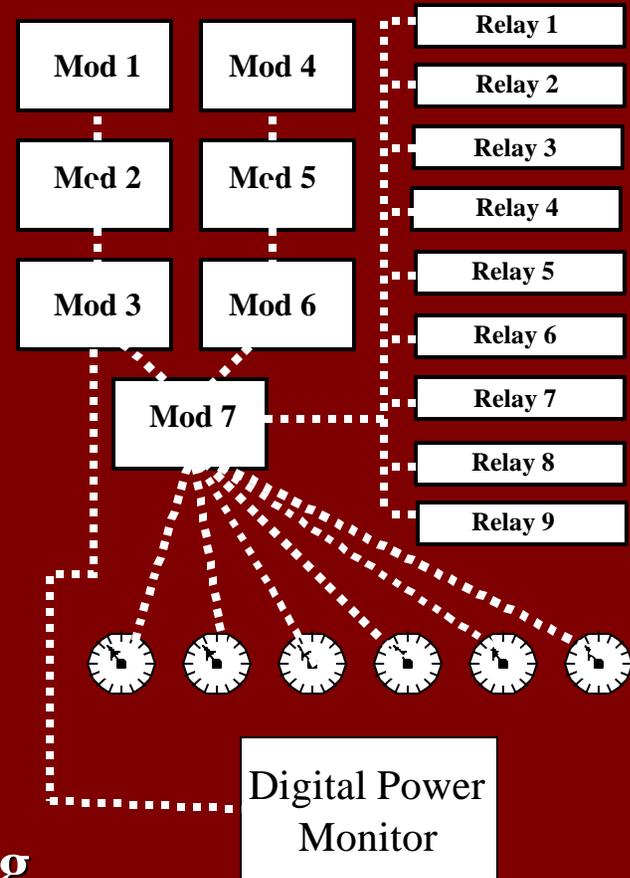
Traditional method



**7 Control Modules  
+ 9 Protective Relays**

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**= 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



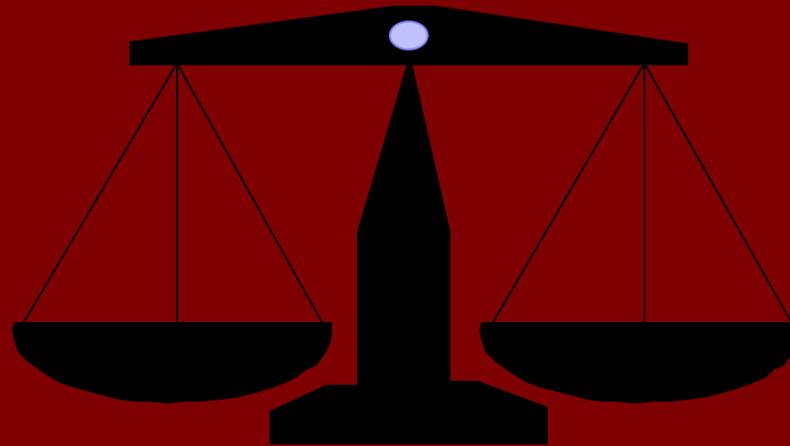
## Interconnection Implications For DER Market At Present?

- **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**



*entelligent-VMM & VPP*  
**Virtual Maintenance Monitor**  
**Virtual Power Plant**

*Example screen-shots*





# entelligent-VPP Navigation Screen

entelligent Virtual Power Plant - C:\Program Files\encorp32

File Edit View Help

System

- Physical Sites
  - Alladdin Industries
  - Axxo Noble
  - Baptist Hospital
  - EMEPA
  - Pfizer
  - St. Thomas Hospital
- User Site Groups
  - Dispatch Groups
    - Economic Dispatch
      - \$0.05/KW
      - \$0.07/kw
      - \$0.09/kw
      - \$0.11/kw
      - \$0.13/kw
    - Fuel Type Dispatch
      - Gas Engines
      - Diesel Engines
      - Duel Fuel Engines
    - Substation Feeders
      - Substation Alpha
      - Substation Bravo
      - Feeder Charle
      - Feeder Delta
    - Regional Dispatch
    - Site Priority Dispatch

Contents of Alladdin Industries

Overview Details History

Distributed Power Information

Distributed Capacity 6400 kW Out Of Service ? kW

Available Power ? kW Power Output ? kW

Verified Power ? kW Requested Power 0 kW

Dispatch and Status

Dispatch Stop Abort

Notification Status

Verified Status

Connection Status:

All Generators Sites

Name	Rated kW	Fuel Type	Emissions Rati...	Full Load Delay	Ru
Gen A at Alladdin Industri...	1600	Diesel			
Gen B at Alladdin Industri...	1600	Diesel			
Gen C at Alladdin Industri...	1600	Diesel			
Gen D at Alladdin Industr...	1600	Diesel			

4 GenSets Logged Off

● Error ● Connecting ● No GenSets  
● Warning ○ Connected ○ Unknown  
● OK ● Verify Needed

**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.**



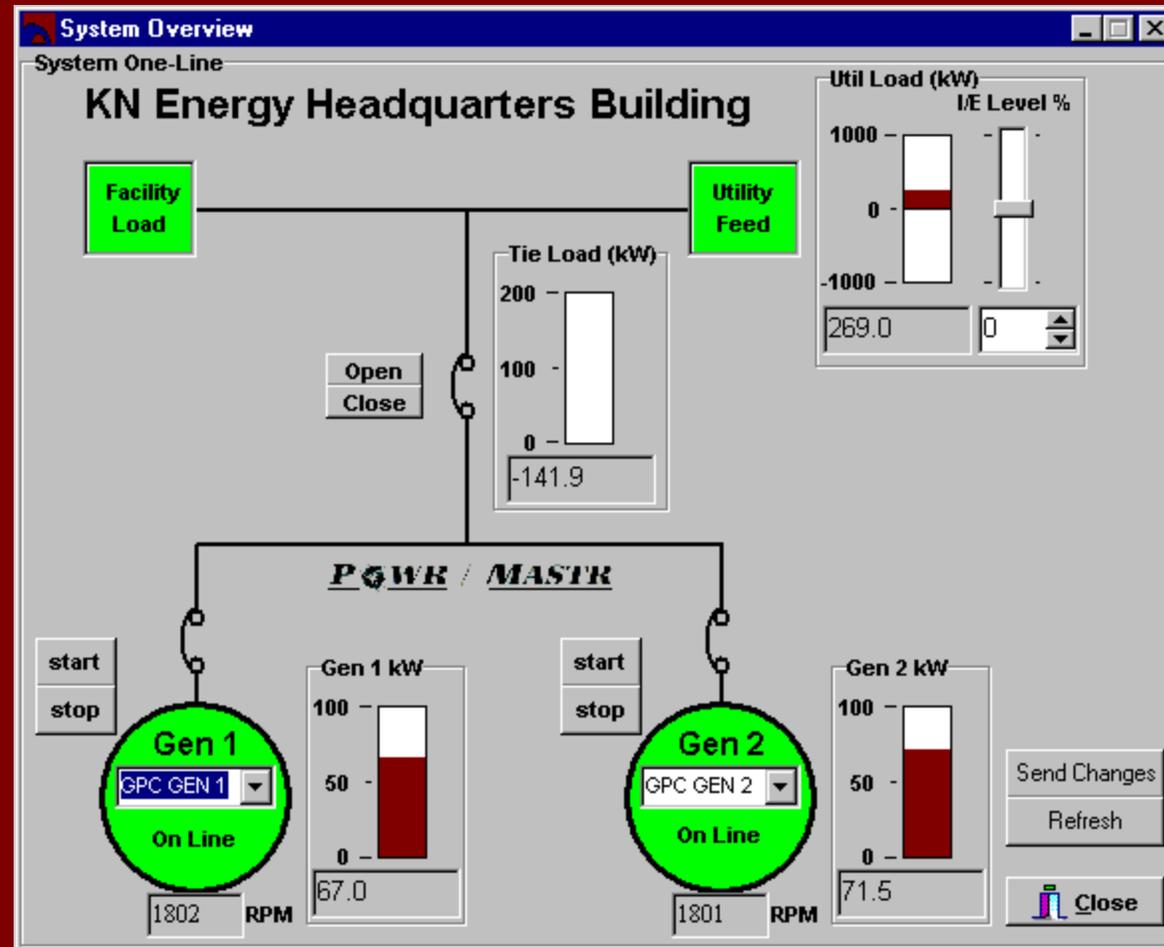
## entelligent-VMM Navigation Screen

Site	Owner	Manager	Empower Control	Connection Status	Node Type	Version	Neuron ID
Beaver Demo	Cutler-Hammer	Cutler-Hammer	GPC GEN 1	Connected	KWS	1.30	00.01.29.27.22.00
CP&L Solutions Ce...	CP&L	CP&L	GPC GEN 2	Connected	KWS	1.30	00.01.29.26.58.00
Controlled Power...	Engine World	Engine World	MMC	Connected	PTC	1.30	00.01.29.26.82.00
Encorp CPM	Encorp	Encorp	UPC	Connected	UPC	1.30	00.01.29.26.70.00
KN Energy	ENCORP/KN	ENCORP/KN					
PNM Gas Services	PNM Gas Servic...	PNM Gas Servic...					
Palmdale, CA	Engine World	Engine Wordl					

Connected to KN Energy

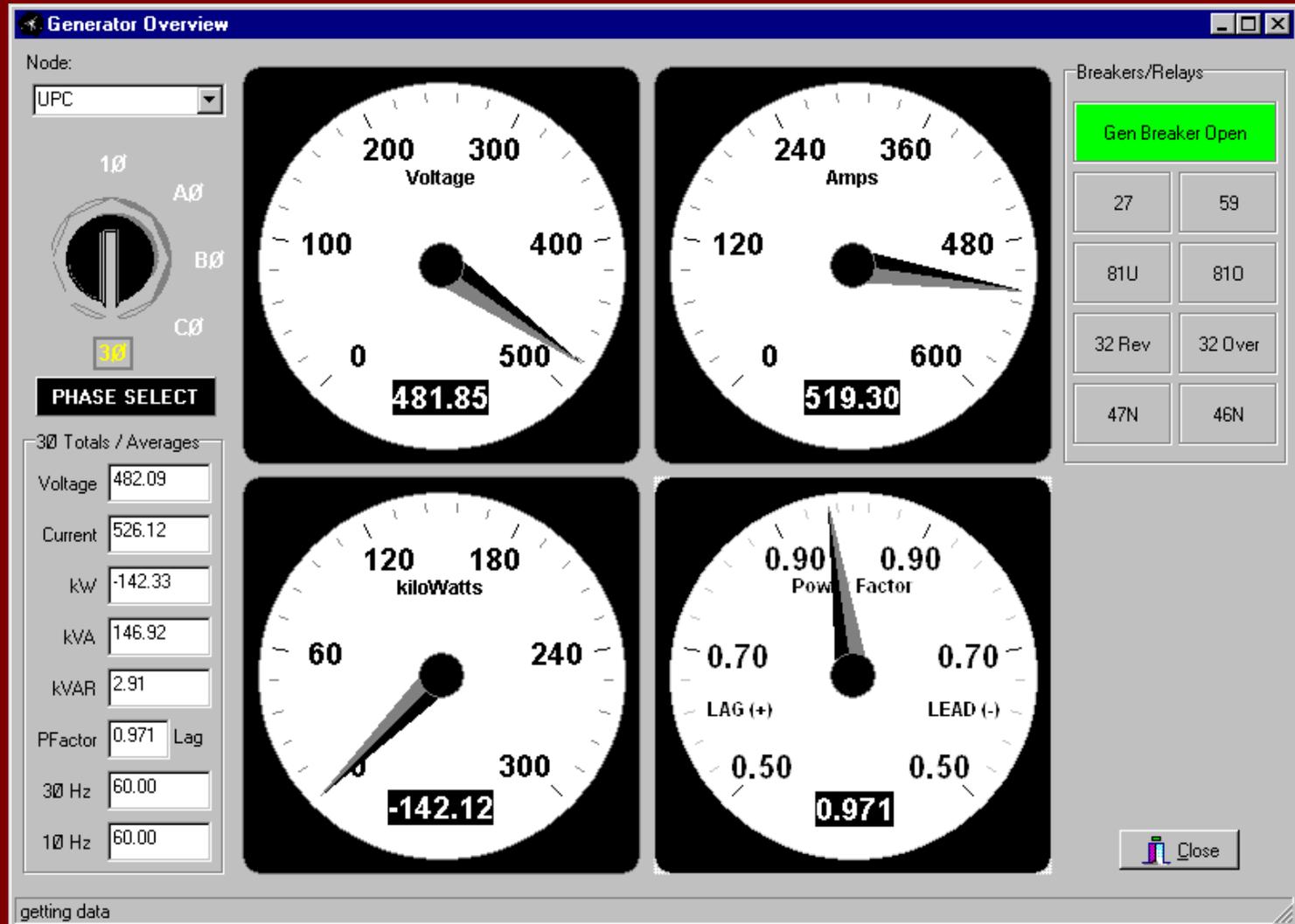
This screen is used for general navigation and site connection to single or multiple distributed energy resource (DER) site(s).

# 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



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

The screenshot displays the 'Engine Overview' interface with the following data:

<b>Engine Speed</b> 1801 RPM	<b>Coolant Temp</b> 170.70 °F	<b>Bearing Temp</b> 97.10 °F	<b>Ambient Temp</b> 44.70 °F
<b>Battery Voltage</b> 14.07 Volts	<b>Oil Pressure</b> 51.80 PSI	<b>Oil Temp</b> 201.10 °F	<b>Fridge Temp</b> 59.60 °F

Engine: **GPC GEN 1** Mode: **On Line** Hours: **280** Generator Power (kW): **67.19**

<b>Alarms</b>			<b>Shutdowns</b>			<b>Switch Status</b>
Common Alarm	Lo Battery Voltage	TC1 Card Failed	Common Shutdown	Lo Battery Voltage	Emergency Stop	OFF
OverSpeed	Lo Control Voltage	TC2 Card Failed	Overspeed	Lo Control Voltage	Lost Speed Signal	In Test
High Coolant Temp	High Oil Temp	Service Oil	High Coolant Temp	Low Oil Level	GPC Shutdown	<b>In Auto</b>
Low Coolant Level	Low Oil Level	Service Plugs	High Oil Temp	High Oil Level	External Shutdown	
High Fridge Temp	Low Oil Pressure	Service Fan Belt	High Fridge Temp	Low Oil Pressure	Oil & Coolant TC Fail	
High Bearing Temp	Oil Reservoir Low	Service Air Filter	High Bearing Temp	High Vibration	4-20 Card Failed	
Hi Battery Voltage	PLC Comm. Error		Hi Battery Voltage	Fail to Start		

<b>Service Dates</b>		<b>Plugs:</b> 979 Hours 12/12/1998 Date		<b>Oil:</b> 479 Hours 11/21/1998 Date		<b>Fan Belt:</b> 979 Hours 12/12/1998 Date		<b>Air Filter:</b> 979 Hours 12/12/1998 Date	
----------------------	--	--	--	--	--	---	--	---	--

Buttons: Start Engine, Stop Engine, Reset Alarms, Close

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

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

Capacity Management Setup Graph

Load (kW)

Time

Utility Load (kW) Stop Generator Start Generator

Demand Limit Setup

Metering Node: MMC Utility Load Variable: oTP\_W\_\_3 Current Demand (kW): 263

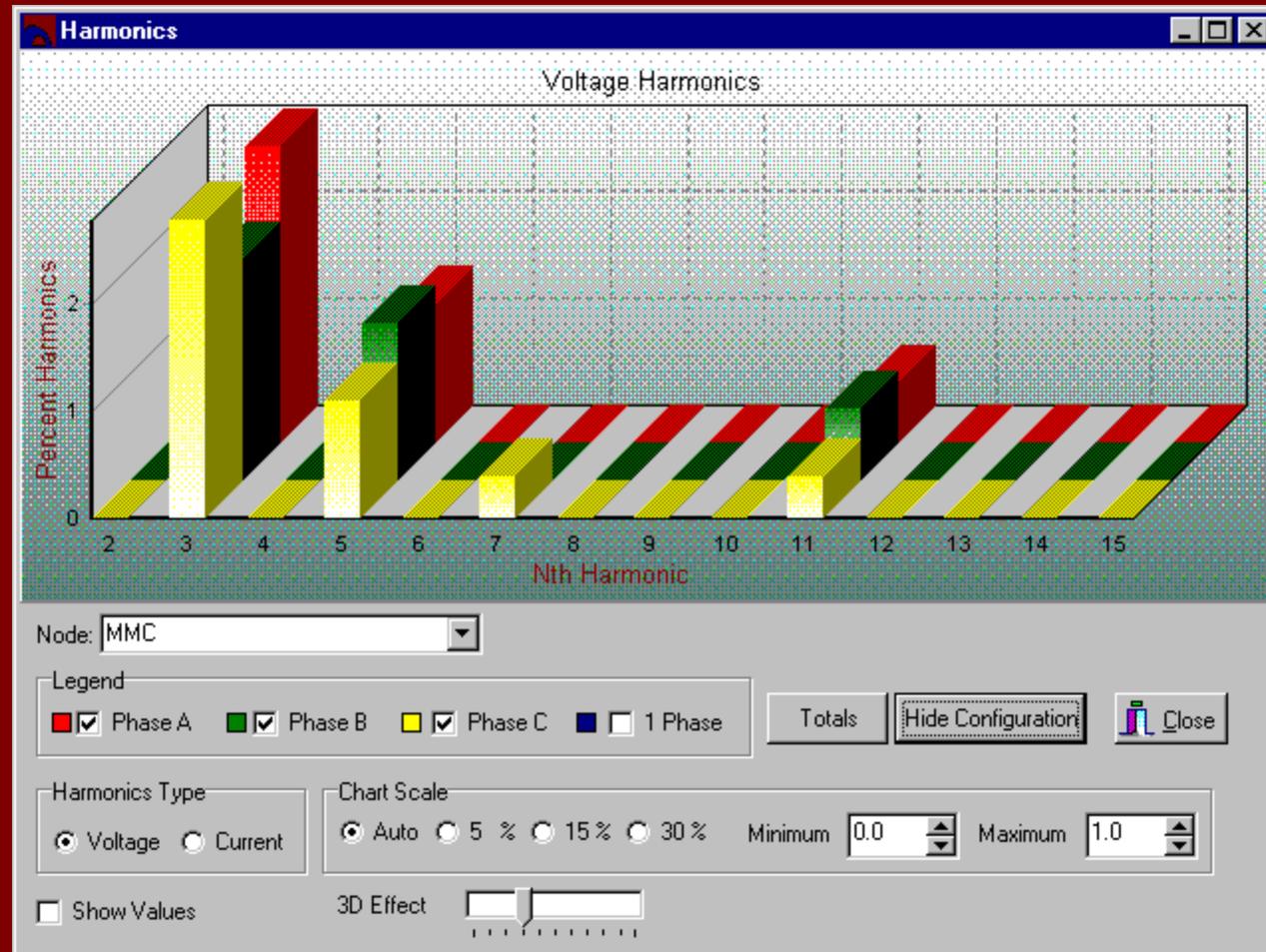
UPC Node: UPC Utility Load Limit: 0.0 GPC BaseLoad Variable: iNAO\_In\_3A\_

Stop/Start Delay (secs): 60 Hysterisis: 75.0 UPC Import/Export Variable: iKWC\_EnPC\_

Apply OK Cancel

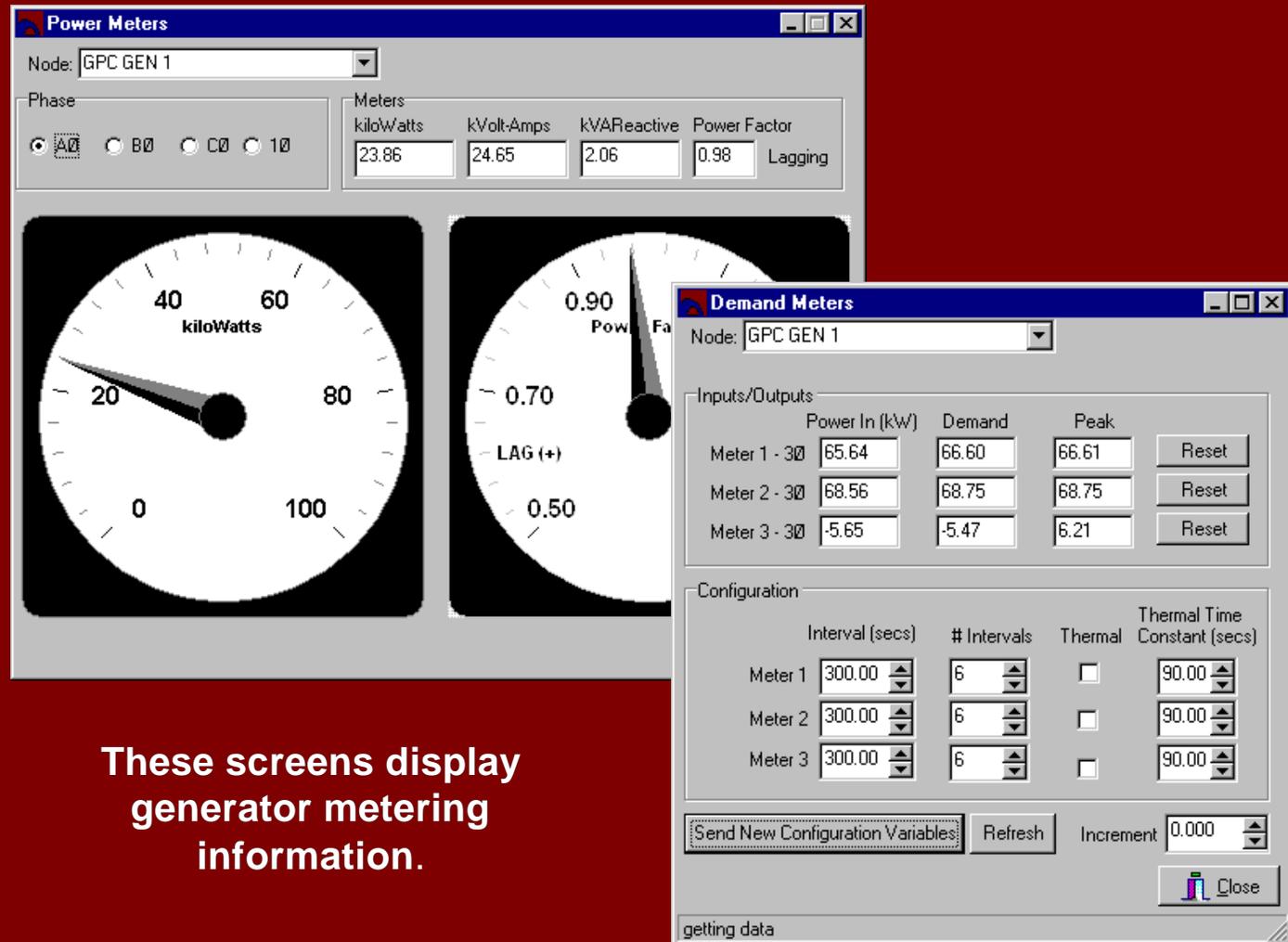
This screen allows the user to perform automatic capacity mgt based on the time of day, days operated and/or building load level.

# 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



The image shows two software windows. The 'Power Meters' window displays real-time data for 'GPC GEN 1' with phase selection (A0 selected) and a table of meter readings. The 'Demand Meters' window shows a table of power in, demand, and peak values for three meters, along with configuration options for intervals and thermal constants.

**Power Meters Data:**

Meters	kiloWatts	kVolt-Amps	kVARreactive	Power Factor
	23.86	24.65	2.06	0.98 Lagging

**Demand Meters Data:**

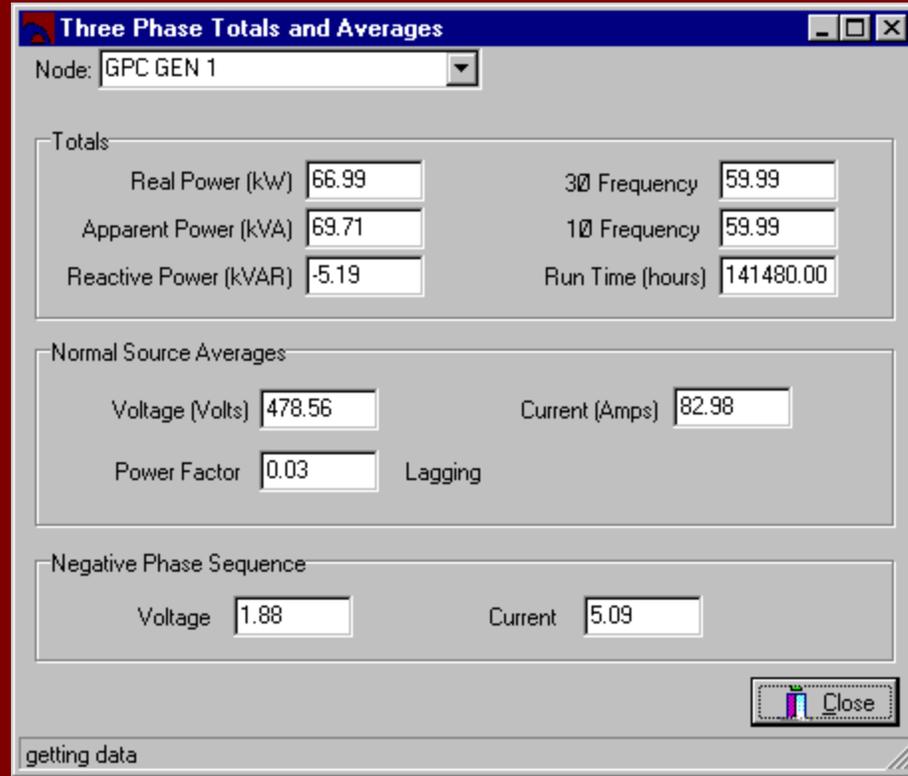
Inputs/Outputs	Power In (kW)	Demand	Peak	Reset
Meter 1 - 3Ø	65.64	66.60	66.61	Reset
Meter 2 - 3Ø	68.56	68.75	68.75	Reset
Meter 3 - 3Ø	-5.65	-5.47	6.21	Reset

**Configuration Data:**

	Interval (secs)	# Intervals	Thermal	Thermal Time Constant (secs)
Meter 1	300.00	6	<input type="checkbox"/>	90.00
Meter 2	300.00	6	<input type="checkbox"/>	90.00
Meter 3	300.00	6	<input type="checkbox"/>	90.00

These screens display generator metering information.

# Power Display Screen



Totals	
Real Power (kW)	66.99
Apparent Power (kVA)	69.71
Reactive Power (kVAR)	-5.19
3Ø Frequency	59.99
1Ø Frequency	59.99
Run Time (hours)	141480.00

Normal Source Averages	
Voltage (Volts)	478.56
Current (Amps)	82.98
Power Factor	0.03 Lagging

Negative Phase Sequence	
Voltage	1.88
Current	5.09

**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: Input, Output, Configuration 1

Annunciator #2: Input, Output, Configuration 1

Annunciator #3: Input, Output, Configuration 1

Annunciator #4: Input, Output, Configuration 1

Annunciator #5: Input, Output, Configuration 1

Annunciator #6: Input, Output, Configuration 1

Annunciator #7: Input, Output, Configuration 1

Annunciator #8: Input, Output, Configuration 1

Annunciator #9: Input, Output, Configuration 1

Annunciator #10: Input, Output, Configuration 1

Annunciator #11: Input, Output, Configuration 1

Annunciator #12: Input, Output, Configuration 1

Annunciator #13: Input, Output, Configuration 1

Annunciator #14: Input, Output, Configuration 1

Annunciator #15: Input, Output, Configuration 1

Annunciator #16: Input, Output, Configuration 1

Audible Output, 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 *enpower* products.**

# Control Setup Screen Example

**Synchronizer Relay - 25A**

Node: GPC GEN 1

**Outputs**

Synchroscope (deg)	0.21	Voltage Bias Output (%)	0.00
Frequency Error (Hz)	-0.07	Hz Bias Output (%)	0.00

 Synchroscope

**Configuration**

Phase Accept Window(+/- deg)	10.03	Phase Offset (deg)	
Voltage Accept Window(+/- Volts)	5.0	Slip Freq Set Point (Hz)	
Slip Accept Range (+/- Hz/sec)	0.10	Breaker Close Time (secs)	
Synchronizer Time Out TDSL (secs)	180.0		

Enable Dead Bus
  Enable:

0

getting data

**Synchroscope**

Node: GPC GEN 1

<b>1Ø Input</b>	<b>SynchroScope</b>	<b>AØ Input</b>
Voltage		Voltage
479.51		478.97
Frequency		Frequency
59.98		59.97

Slow (Dial Up)
  Fast (LAN)

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
----	------	----	------	----	------	----	------

**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

**Outputs**

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

Reactive Power Control Mode

     Increment   0.000  

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



# Control Setup Screen Example

**ATS Control** [Node: UPC]

**Inputs:**

- Normal NOT Available
- Normal Breaker Open
- Emergency NOT Available
- Emergency Breaker Open
- ATS NOT in Test Mode
- Open Transfer Selected
- ATS NOT in Auto
- Reset/Rexfer Input OFF
- Service Input OFF

**Outputs:**

- Stop Emergency
- Emergency NOT Failed
- Synchronizing OFF
- NOT Synchronizing Normal
- NOT Transferring
- NOT Retransferring to Normal
- Open Transfer Timer OFF
- ATS Control Mode
- Manual Transfer

**Configuration Times (seconds):**

Time Delay Emergency Start (TDES) seconds	5.0	Time Delay Neutral (TDN) seconds	5.0
Time Delay Normal to Emerg (TDNE) seconds	5.0	Time Delay Crank Limit (TDCL) seconds	30.0
Time Delay Emerg to Normal (TDEN) seconds	15.0	Time Delay Emergency Cooldown (TDEC) seconds	5.0

Send New Configuration Variables Refresh Increment 0.000 Close

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



# Example Protective Relay Setup Screens

**NegPhaseSequenceVoltageRelayForm**

Node: GPC GEN 1

Configuration

Limits (Volts)	Hysterisis (Volts)
Hi-Hi: 100.0	Hi-Hi: 5.0
Hi: 50.0	Hi: 5.0

Set Times (seconds)

Hi: 5.00	Hi-Hi: 1.00
----------	-------------

Clear Times (seconds)

Hi: 20.00	Hi-Hi: 20.00
-----------	--------------

Send New Configuration Variables Refresh

getting data

**Utility Frequency Relay**

Node: GPC GEN 1

Configuration

Limits (Hz)	Hysterisis (Hz)
Hi-Hi: 65.00	Hi-Hi: 0.20
Hi: 61.00	Hi: 0.20
Lo: 59.00	Lo: 0.20
Lo-Lo: 25.00	Lo-Lo: 0.20

Set Times (seconds)

Lo, Hi: 1.00	Lo-Lo, Hi-Hi: 1.00
--------------	--------------------

Clear Times (seconds)

Lo, Hi: 1.00	Lo-Lo, Hi-Hi: 1.00
--------------	--------------------

Send New Configuration Variables Refresh Increment 0.000 Close

getting data

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



**New Site** [X]

General | Connection | **Location**

Address

Street

City

State or Prov  ZIP or Loc code

Country

Latitude

deg  m  s  N  S

Longitude

deg  m  s  E  W



**New Site** [X]

**General** | Connection | Location

Site Name

Site Owner

Manager

Utility

Rated Maximum Power (kW)

Site Icon

Current:  Available:

**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 *enpower* - RTU

- An adaptation of *ENCORP*'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*