Smart Inverter Communication Initiative

Project Overview and Status

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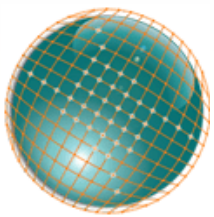

4th International Conference on
Integration of Renewable and Distributed Energy Resources
December 6-10, 2010
Albuquerque, NM, USA

Conference Sponsors

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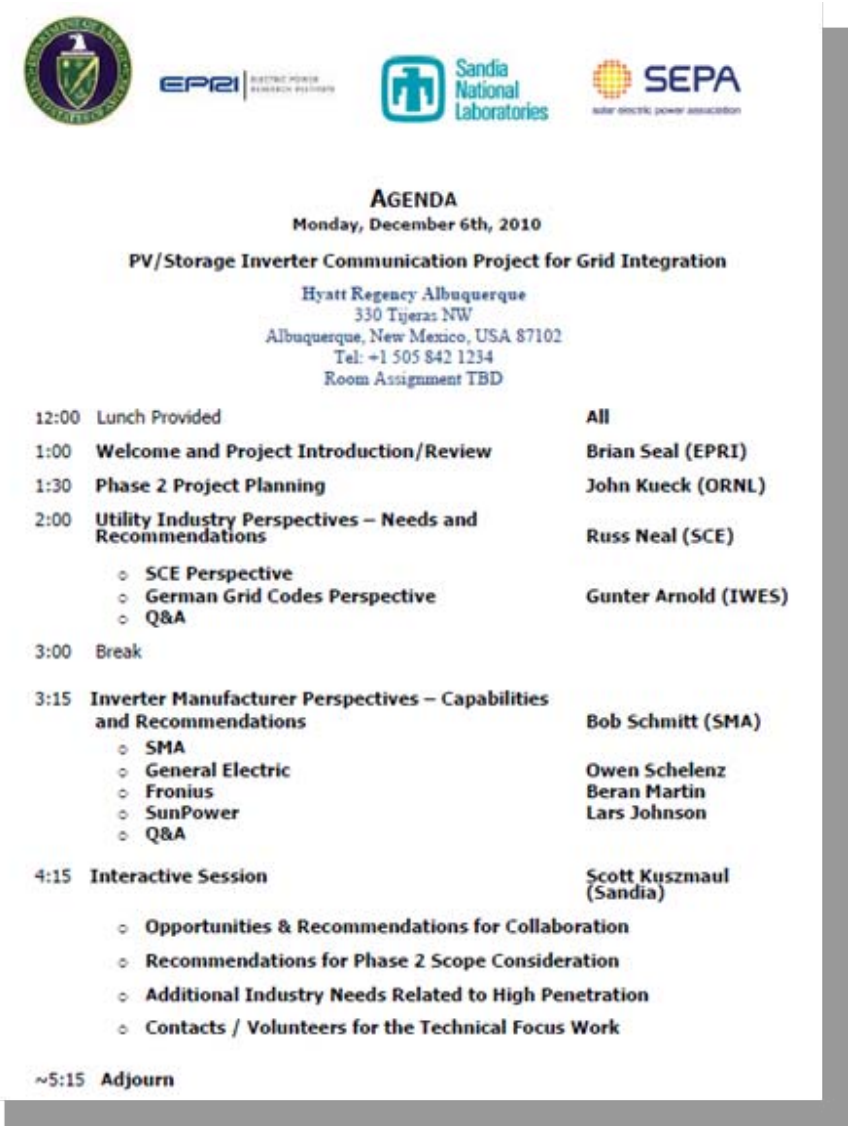
Goals of Today's Workshop

1. Introduce and review the work completed thus far
2. Present for discussion the planned Phase2 topics
3. Facilitate open dialogue regarding past work, emerging utility needs, and inverter capabilities. Make adjustments to plans.
4. Gain a better understanding of international activities and opportunities for collaboration
5. Identify volunteers for the technical focus group for phase 2 and interest in prototyping and testing

Agenda



AGENDA

Monday, December 6th, 2010

PV/Storage Inverter Communication Project for Grid Integration

Hyatt Regency Albuquerque
330 Tijeras NW
Albuquerque, New Mexico, USA 87102
Tel: +1 505 842 1234
Room Assignment TBD

12:00	Lunch Provided	**All**
1:00	**Welcome and Project Introduction/Review**	**Brian Seal (EPRI)**
1:30	**Phase 2 Project Planning**	**John Kueck (ORNL)**
2:00	**Utility Industry Perspectives – Needs and Recommendations**	**Russ Neal (SCE)**
	○ **SCE Perspective**	
	○ **German Grid Codes Perspective**	**Gunter Arnold (IWES)**
	○ **Q&A**	
3:00	Break	
3:15	**Inverter Manufacturer Perspectives – Capabilities and Recommendations**	**Bob Schmitt (SMA)**
	○ **SMA**	
	○ **General Electric**	**Owen Schelenz**
	○ **Fronius**	**Beran Martin**
	○ **SunPower**	**Lars Johnson**
	○ **Q&A**	
4:15	**Interactive Session**	**Scott Kuszmaul (Sandia)**
	○ **Opportunities & Recommendations for Collaboration**	
	○ **Recommendations for Phase 2 Scope Consideration**	
	○ **Additional Industry Needs Related to High Penetration**	
	○ **Contacts / Volunteers for the Technical Focus Work**	
~5:15	**Adjourn**	

DNP3 Mapping – Draft for Review

DNP Application Note AN2010-001
DRAFT Version 2010-12-03

DNP3 Profile for Photovoltaic Generation and Storage

1 Introduction

This document describes a standard data point configuration, set of protocol services and settings – also known as a *profile* – for communicating with photovoltaic generation and storage systems using DNP3. The purpose of defining this profile is to make it easier to interconnect the DNP3 masters and outstations that are used to control such systems.

Although this document describes a DNP3 profile, it is designed based on the structured *data models* of the International Electrotechnical Commission (IEC) 61850 protocol standards family. In particular, it is based on those data models that are specific to distributed generation and photovoltaic systems. The intent is that a system implementing this DNP3 application note can be easily integrated with an IEC 61850 network by means of a gateway, while remaining conformant with DNP3 best practices.

With these goals in mind, the design of this profile is based on the following documents:

- *IEC 61850-7-420 Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes*. This document is the IEC specification for standard data models to be used for distributed energy resources such as photovoltaic systems.
- *Specification for Photovoltaic and Storage Interactions using IEC 61850 Object Models and Capabilities*. This document was produced by the Photovoltaic Inverter Data Identification Focus Group (DIFG), organized by the Electric Power Research Institute (EPRI). The members of this group include photovoltaic inverter and storage manufacturers, utilities, research institutions and integrators. The document specifies the minimum set of application functions required for communicating with a photovoltaic system. It describes how to implement these functions using IEC 61850 and specifies enhancements to IEC 61850-7-420 to make it more comprehensive for photovoltaic systems.
- *IEC 61850-80-2 Communication networks and systems for power utility automation – Part 80-2: Guideline for exchanging information between networks implementing IEC 61850 and IEEE 1815 (DNP3) (in development)*. This is the current title of the emerging specification for mapping data between IEC 61850 and DNP3 networks and for configuring a gateway between

DNP3 Mapping

Table 12 – Analog Output Point List

Point Index	Name	Supported Control Operations			Transmitted Value		Scaling		Units	Reso-lution	Default Event Class		IEC 61850			
		Select/Operate	Direct Operate	Direct Operate – No Ack	Minimum	Maximum	Multi-plier	Off-set			Chg	Cmd	LN Class	LN Inst	Data Object	CDC
0	Time window for Connect/Disconnect	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	1	WinTms	ING
1	Timeout period for Connect/Disconnect	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	1	RevtTms	ING
2	Time window for limited Watts mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	2	WinTms	ING
3	Timeout period for limited Watts mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	2	RevtTms	ING
4	Ramp time for limited Watts mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	2	RmpTms	ING
5	Time window for fixed power factor mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	3	WinTms	ING
6	Timeout period for fixed power factor mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	3	RevtTms	ING
7	Ramp time for fixed power factor mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	3	RmpTms	ING
8	Time window for charge or discharge rate mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	4a	WinTms	ING
9	Timeout period for charge or discharge rate mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	4a	RevtTms	ING
10	Ramp time for charge or discharge rate mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	4a	RmpTms	ING
11	Time window for price mode	X	X	X	0	2147483647	1	0	Seconds	1	2	2	DOPM	4b	WinTms	ING

DNP3 Mapping – What it Could Provide

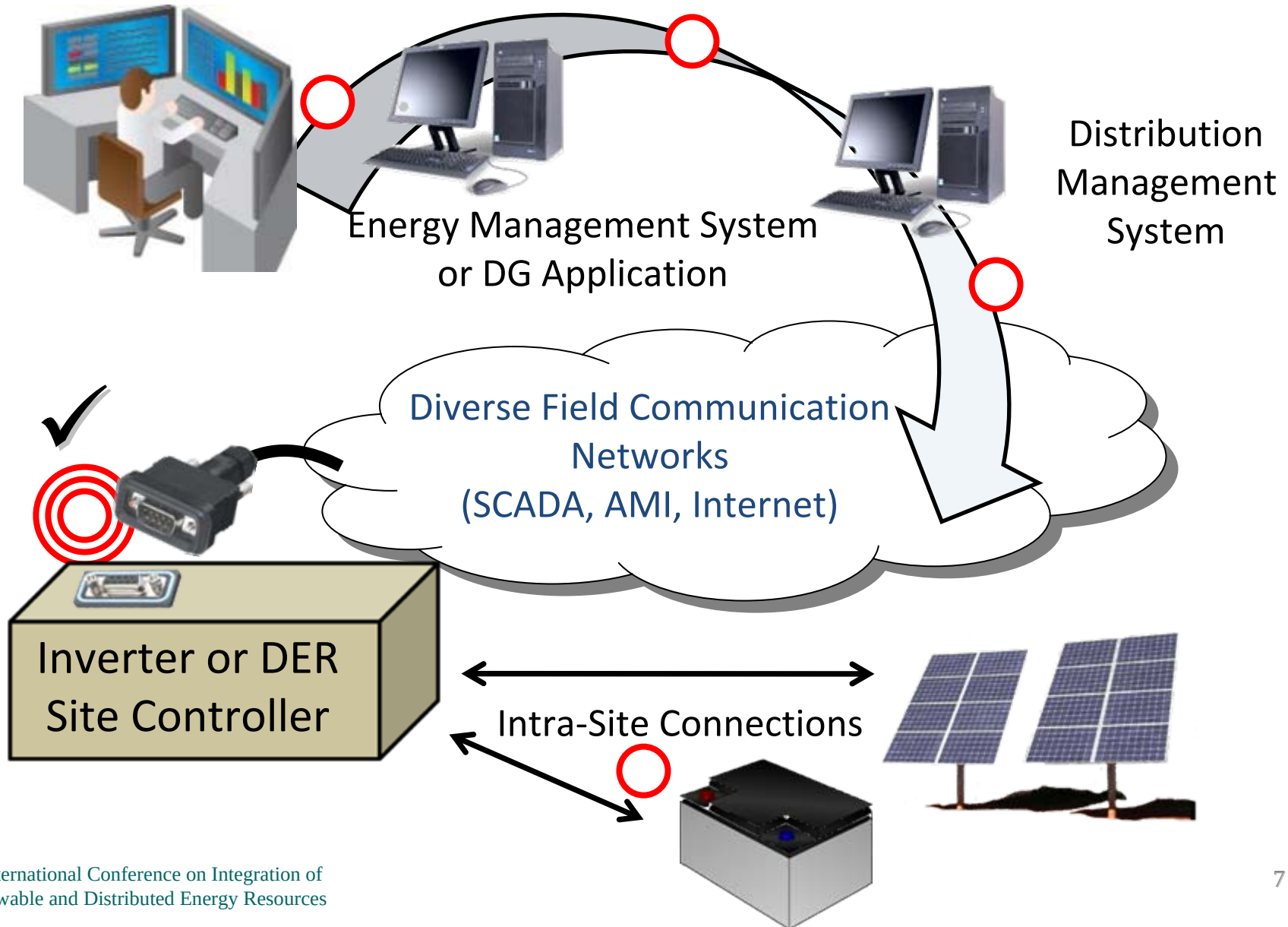
For the Phase 1 Functions :

- An inverter provider could design to these documents and be compatible with multiple types of monitoring and management software/systems.

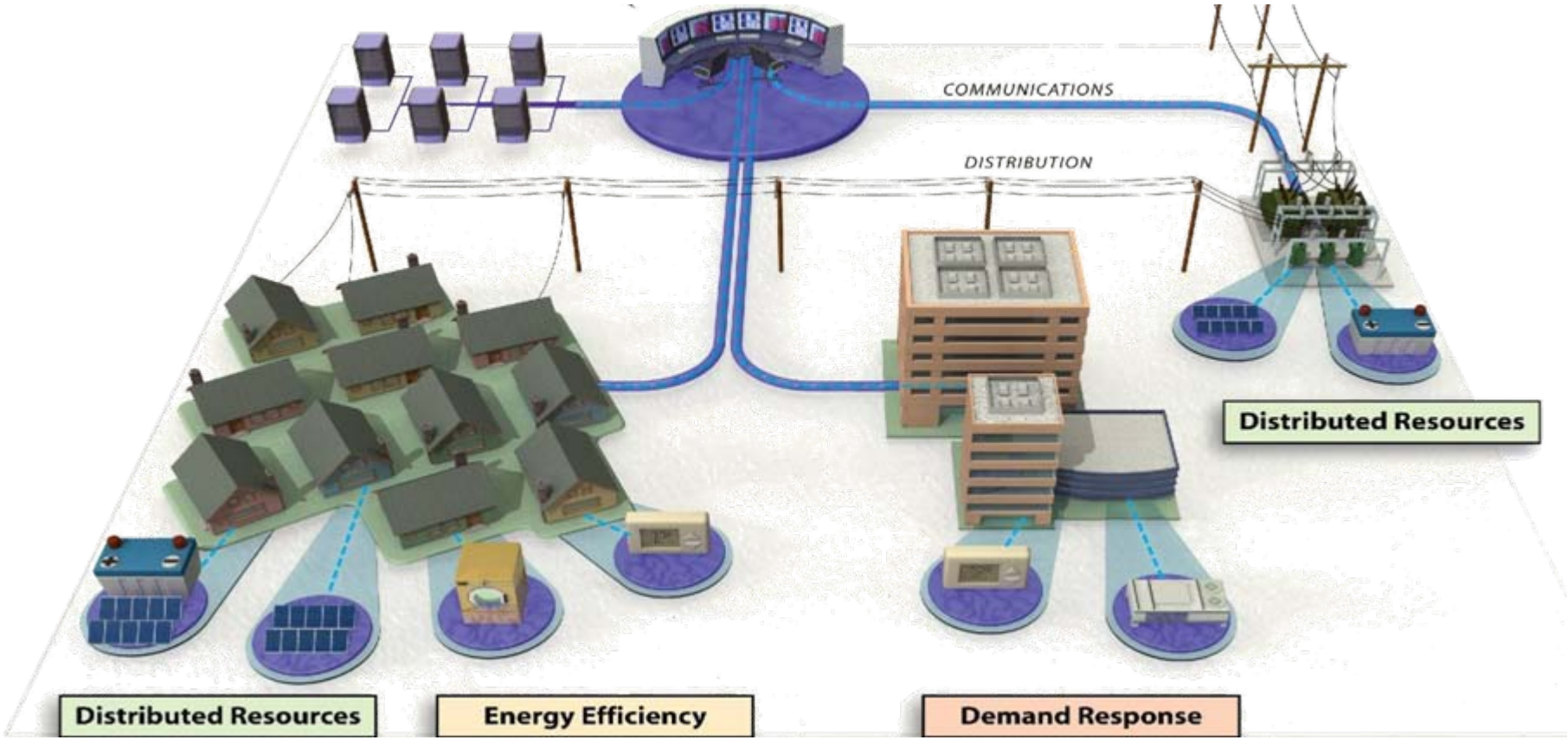
- A DER management software provider could design to these documents and be compatible with multiple types of resources and inverters.

- An interoperability testing or compliance certification facility could evaluate products of all kinds with one another and against the specification.

Applicability Focus: The Local Interface

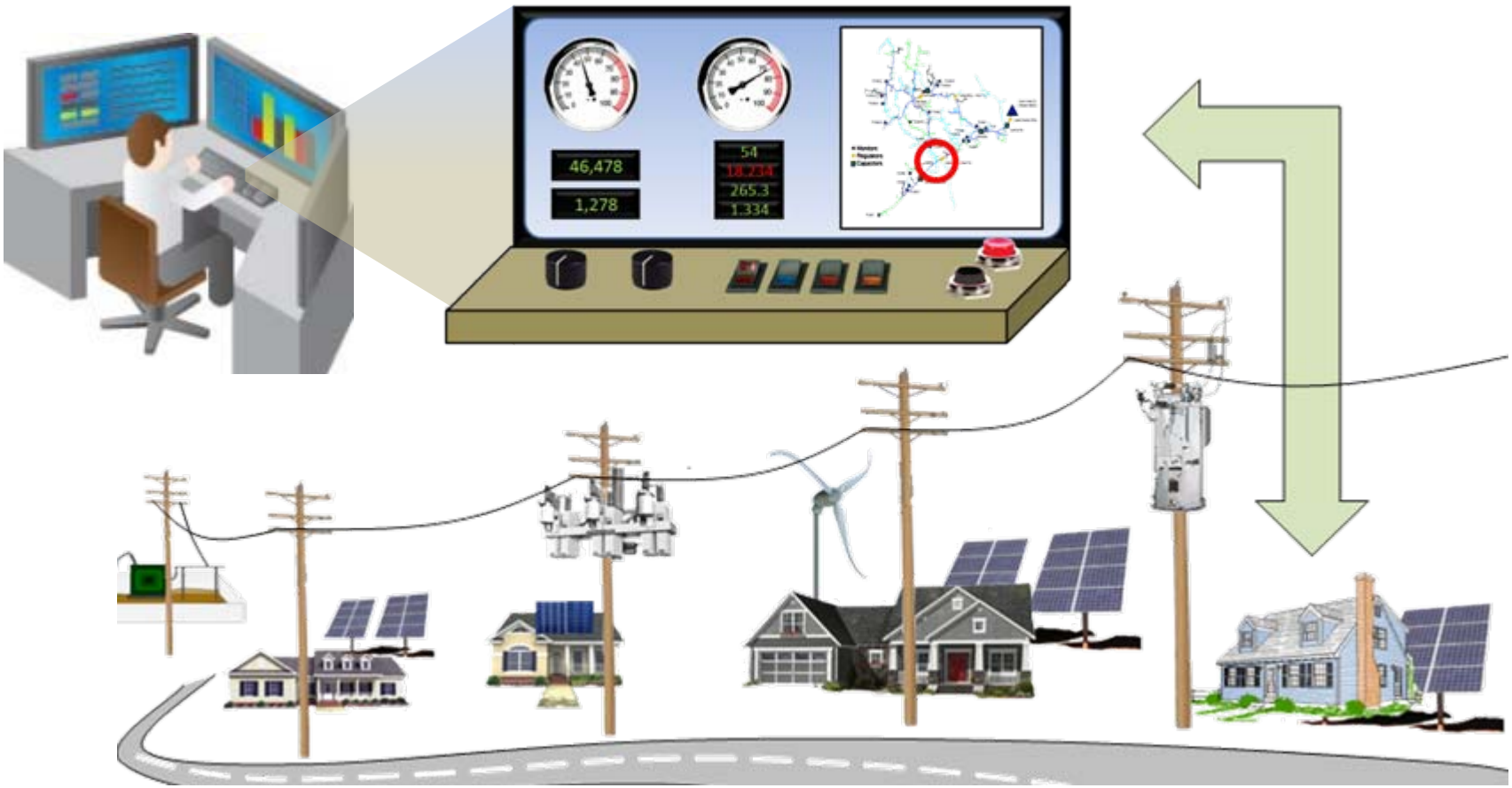


Vision for Smart Inverters



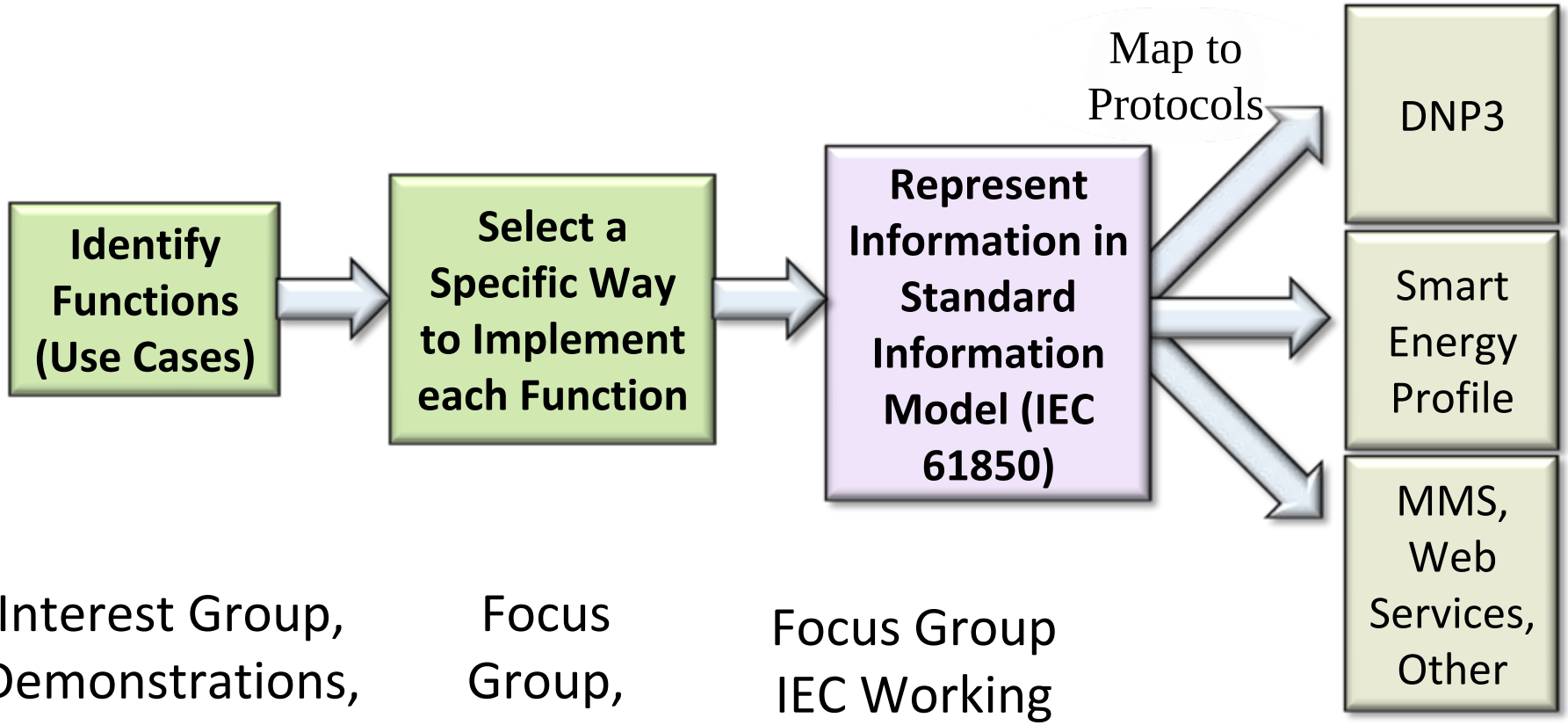
Communication-Connected Distributed Solar and Storage Systems Serving as Beneficial Distribution System Assets

Problem Statement



Need to provide grid operators with **uniform** monitoring and management capability for **large numbers** of **diverse** inverter systems

Related Activities and Sequence



Interest Group, Demonstrations, PAP7, IEEE 1547

Focus Group, Others?

Focus Group IEC Working Group

Standards Groups, Funded Efforts

SEP2 Mapping

- The SEP2 protocol is the most prominent for residential HAN integration.
- Mapping currently in process. Expected to be available for public review from the SEP people by the end of the year.
- Coordinated with SunSpec prior to starting the mapping – included Phase 1 functions plus extensive status/monitoring points defined by SunSpec.

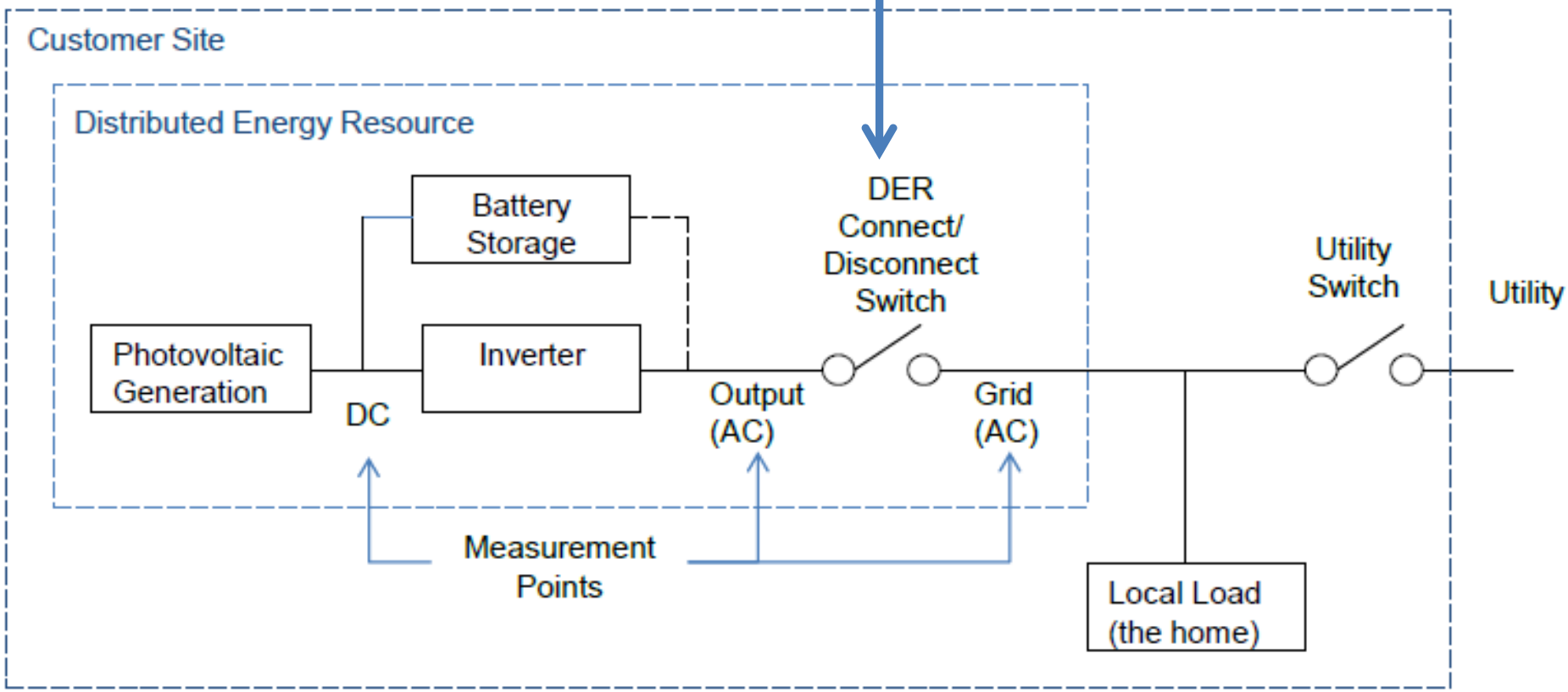
Phase 1 Functions

- Connect/Disconnect – Non Islanding
- Max Generation Level Control
- Smart VAR Management and PF
- Storage Management
- State/Status Monitoring
- Event Logging
- Time Adjustment

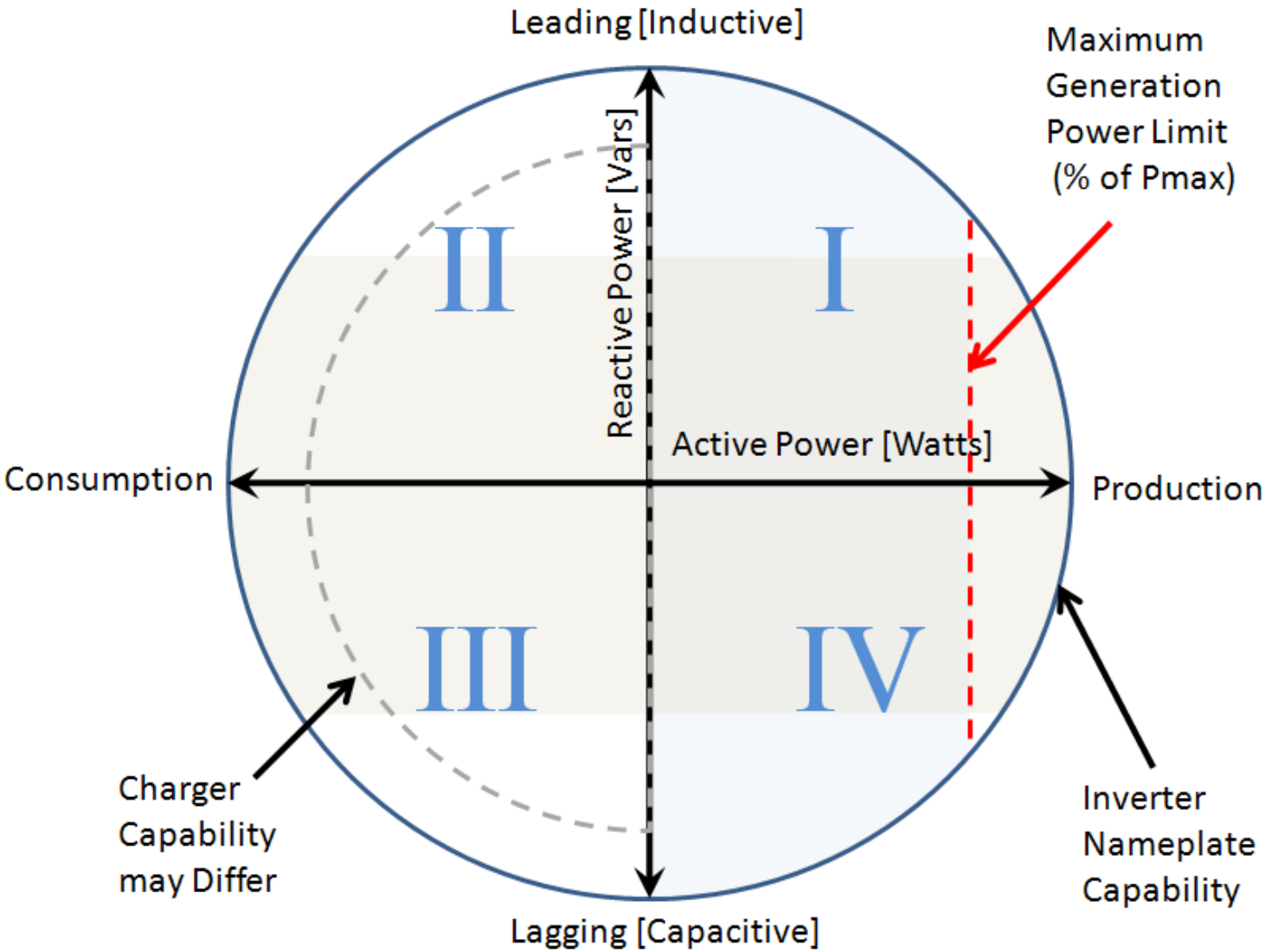
Connect/Disconnect

Management of this Switch

- Not the same as Power = 0
- Randomizable



Max Generation Level Control



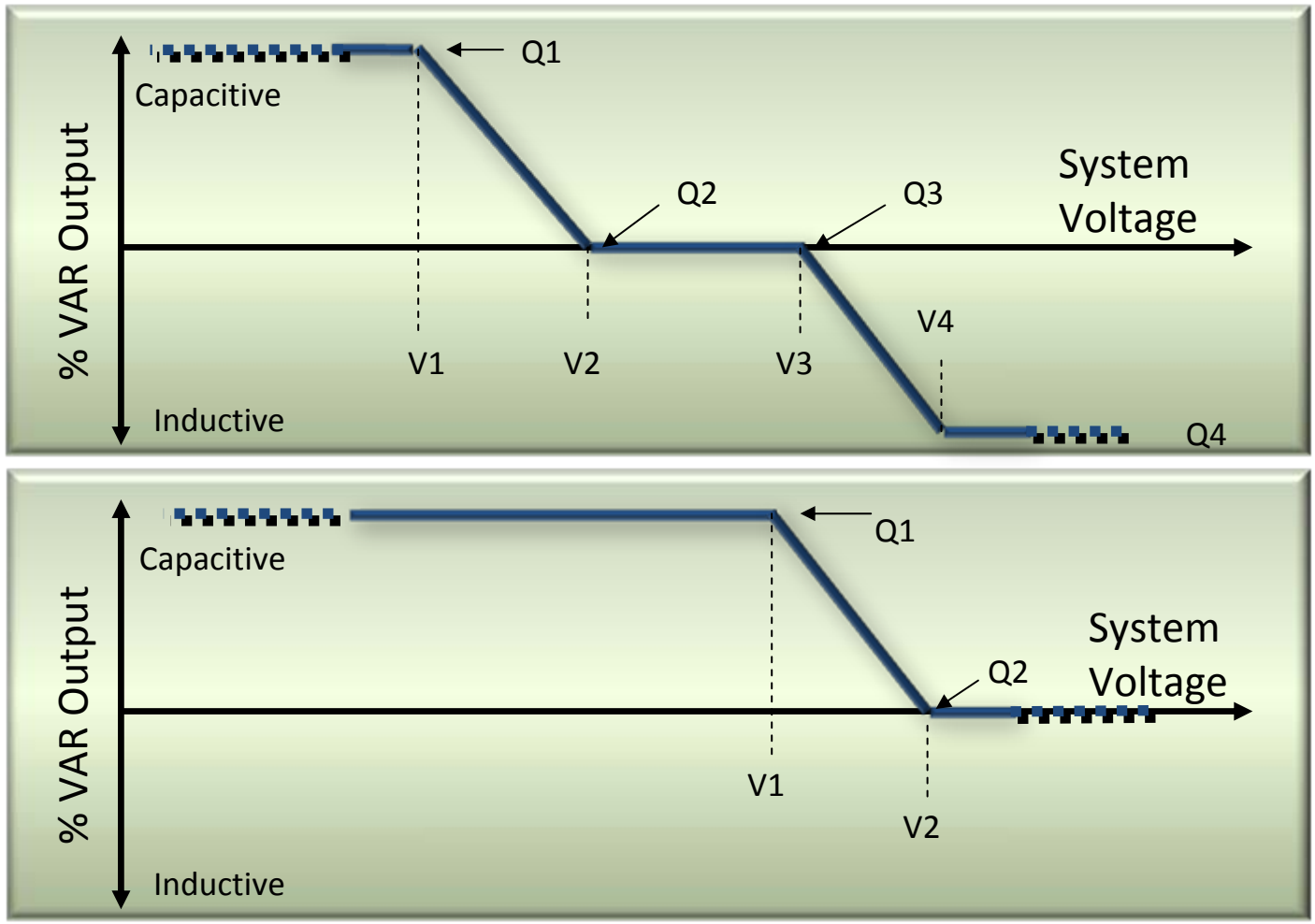
VAR Management

Volt/Var Mode 1

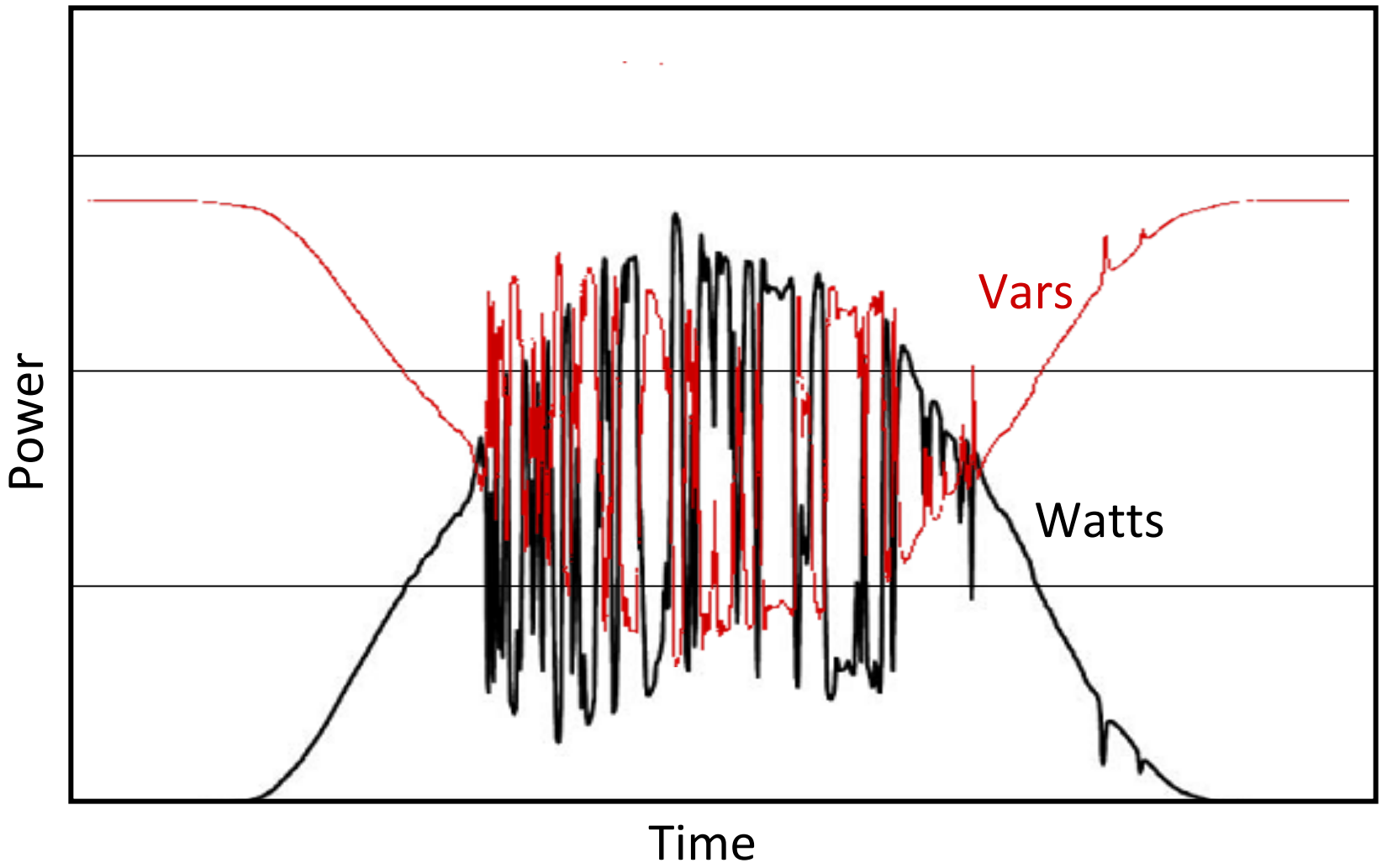
Comm Broadcast or Schedule Driven

Volt/Var Mode 2

Operator-Defined Curve Shapes



VAR Management



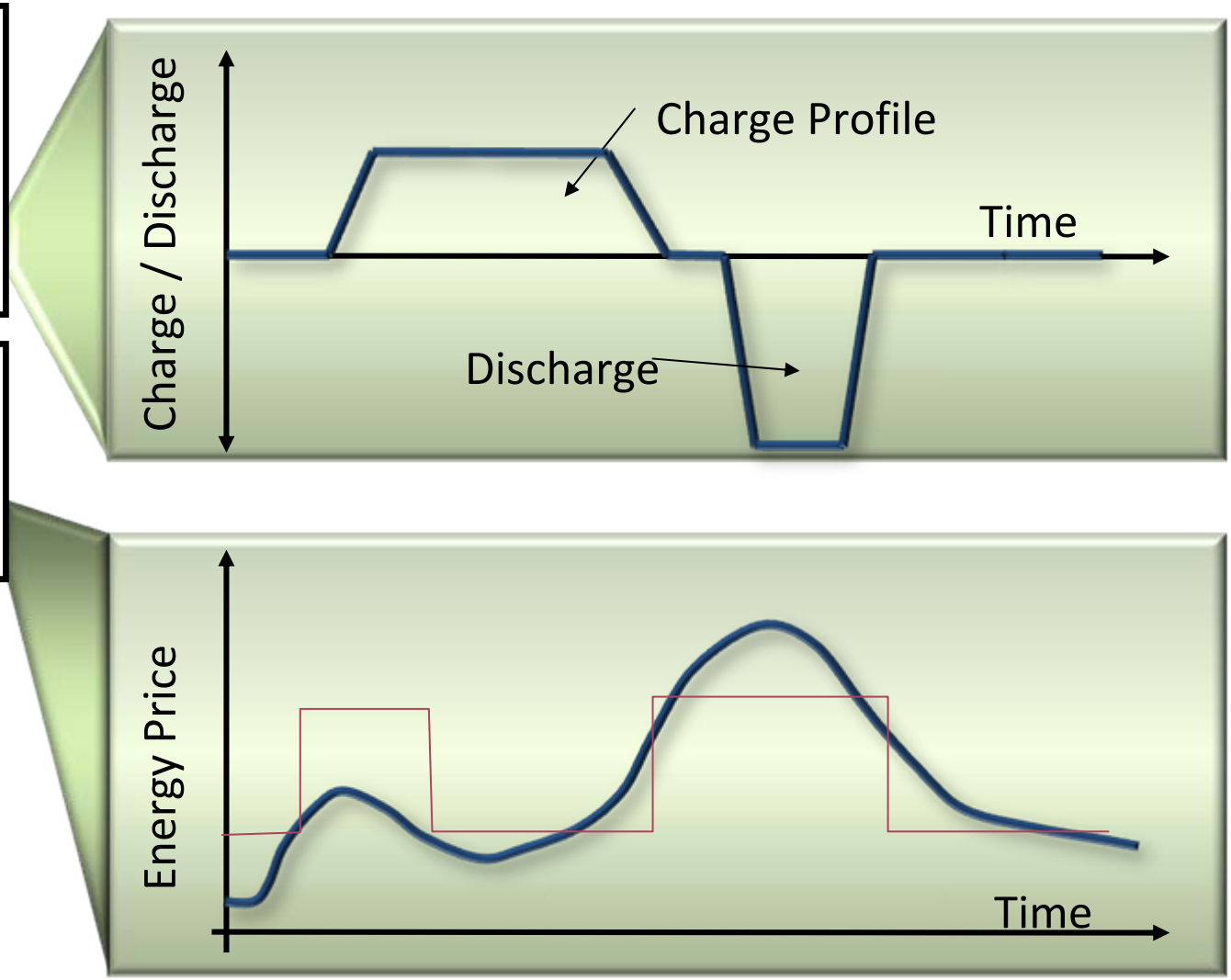
Storage Management

Charge/Discharge Command (%)

Charge/Discharge Schedule

Price Setting

Price Schedule



- Randomization
- Minimum Charge
- Maximum Rate of Charge/Discharge

Monitoring & Logging

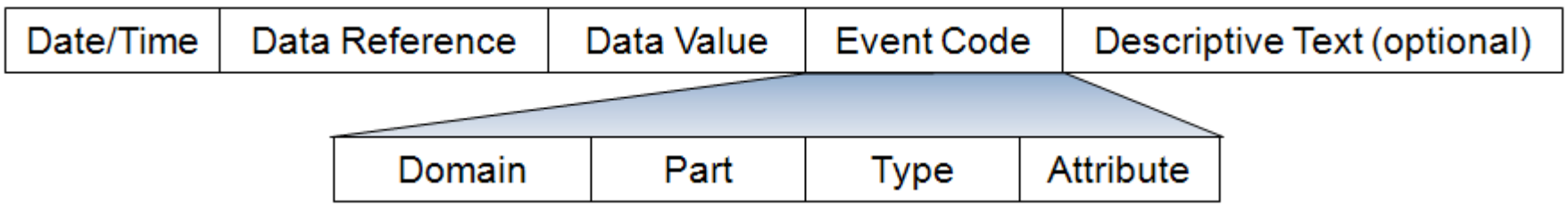
Monitoring

39 specific status items covered, touching the following areas:

- General Status Information
- Power Measurements
- Battery Storage Status
- Nameplate and Settings

Logging

- Starting list of 39 event codes identified
- Circular buffers



Sample Work Products

Whitepaper Describing the Overall Initiative

http://my.epri.com/portal/server.pt?Abstract_id=000000000001020906

Phase 1 Functions Defined and 61850-7-420 Mapped

NIST PAP7 Twiki http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP07Storage

EPRI Website http://my.epri.com/portal/server.pt?Abstract_id=000000000001021674

Standard DNP3 Mapping of Phase 1 Functions

Ready for review, available on FTP site. To be released as a DNP3 Application Note for DER

Standard SEP2.0 Mapping of Phase 1 Functions

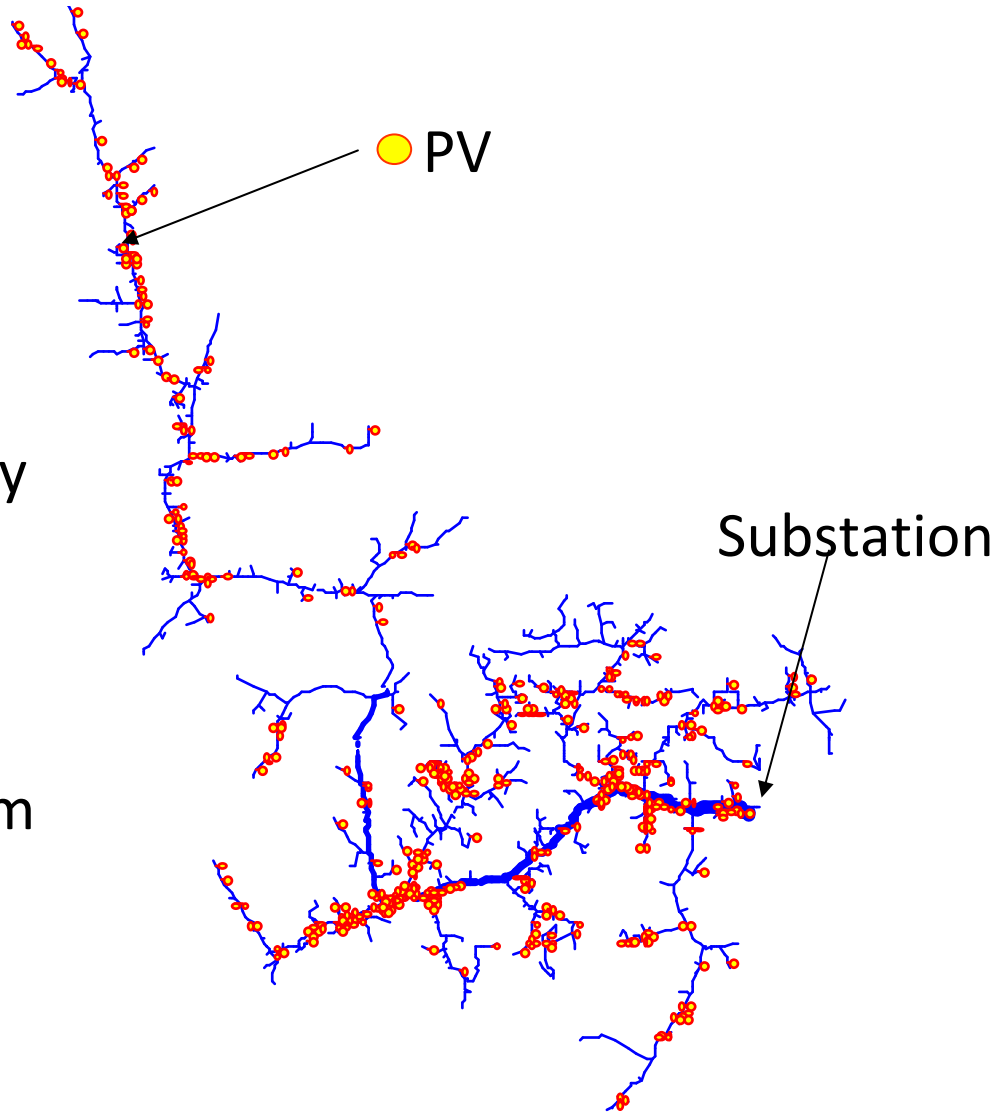
Coordinated with SunSpec. To be part of the SEP2.0 Release

Meeting Reports, Proposed Phase 2 Work, Documented on the Initiative's FTP Site

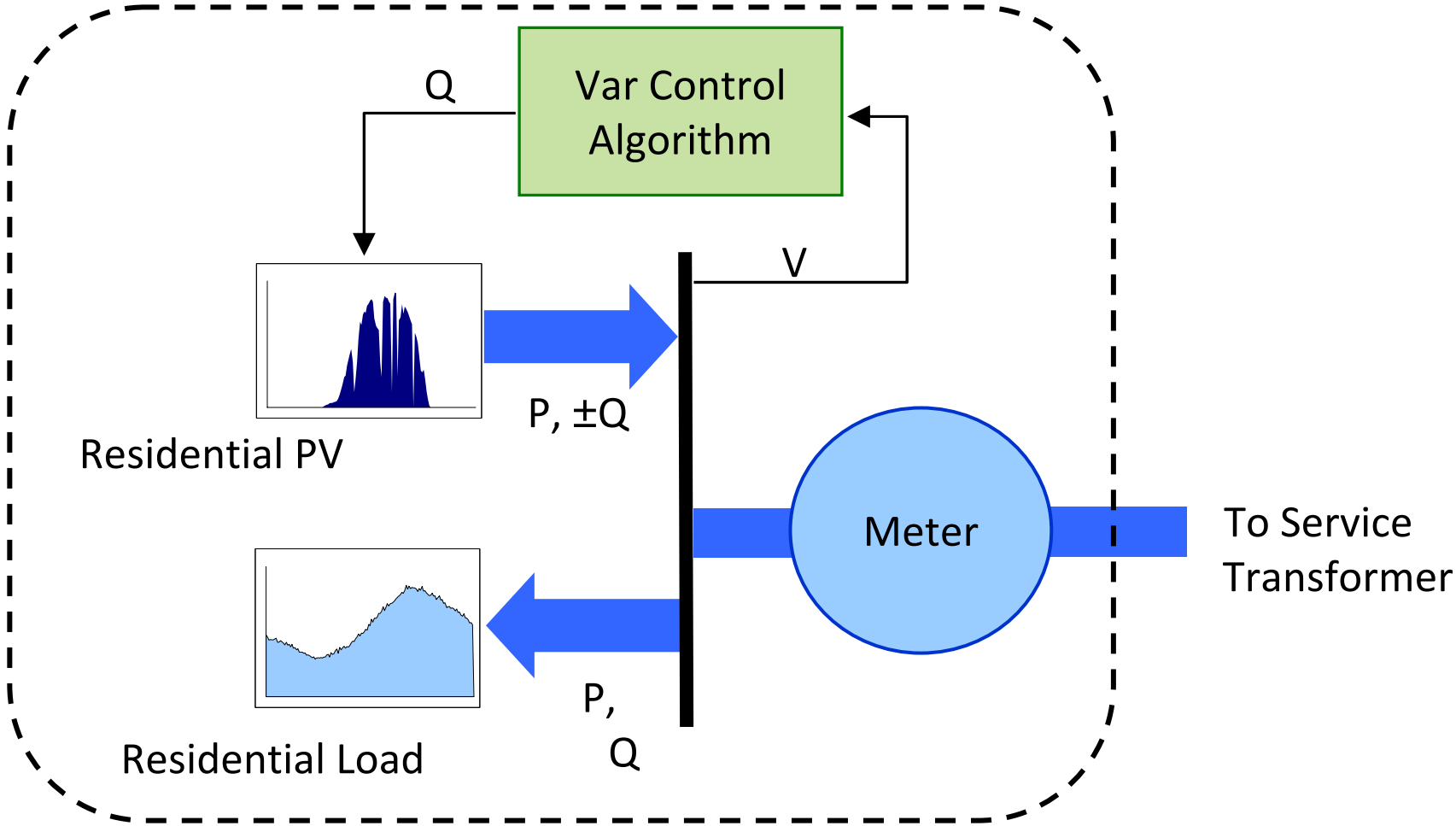
ftp://PVCommunication:Member@ftp.epri.com/

Circuit Impact Modeling

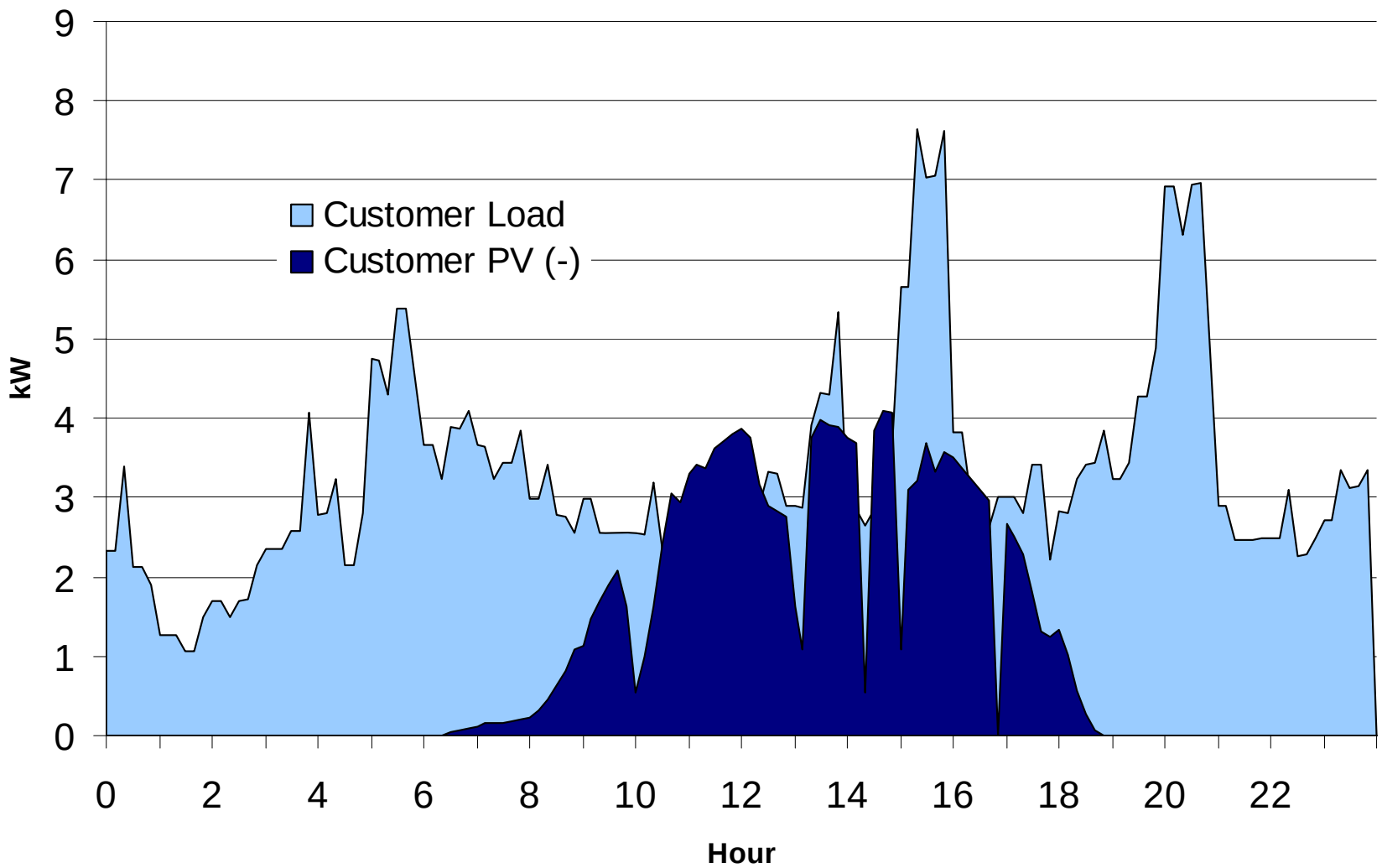
- Actual 12kV feeder
- 1800 customers
- ~10MW Peak load
- ~ 17 mi 3-phase primary
- ~ 115 mi 1-phase primary
- 20% PV penetration, customers randomly selected
- Each with 4KW PV system



Volt-Var Inverter Simulation Model



Example PV and Customer Load Shape



Resulting Effect on Service Voltage