



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

ComEd

An Exelon Company

New Communications Standards for Distributed Generation and Storage

Grant Gilchrist

Principal Consultant, Smart Grid Engineering Team

EnerNex

EPRI Smart Distribution and Power Quality

Conference and Exhibition

June 17-19, 2013

Problem Statement

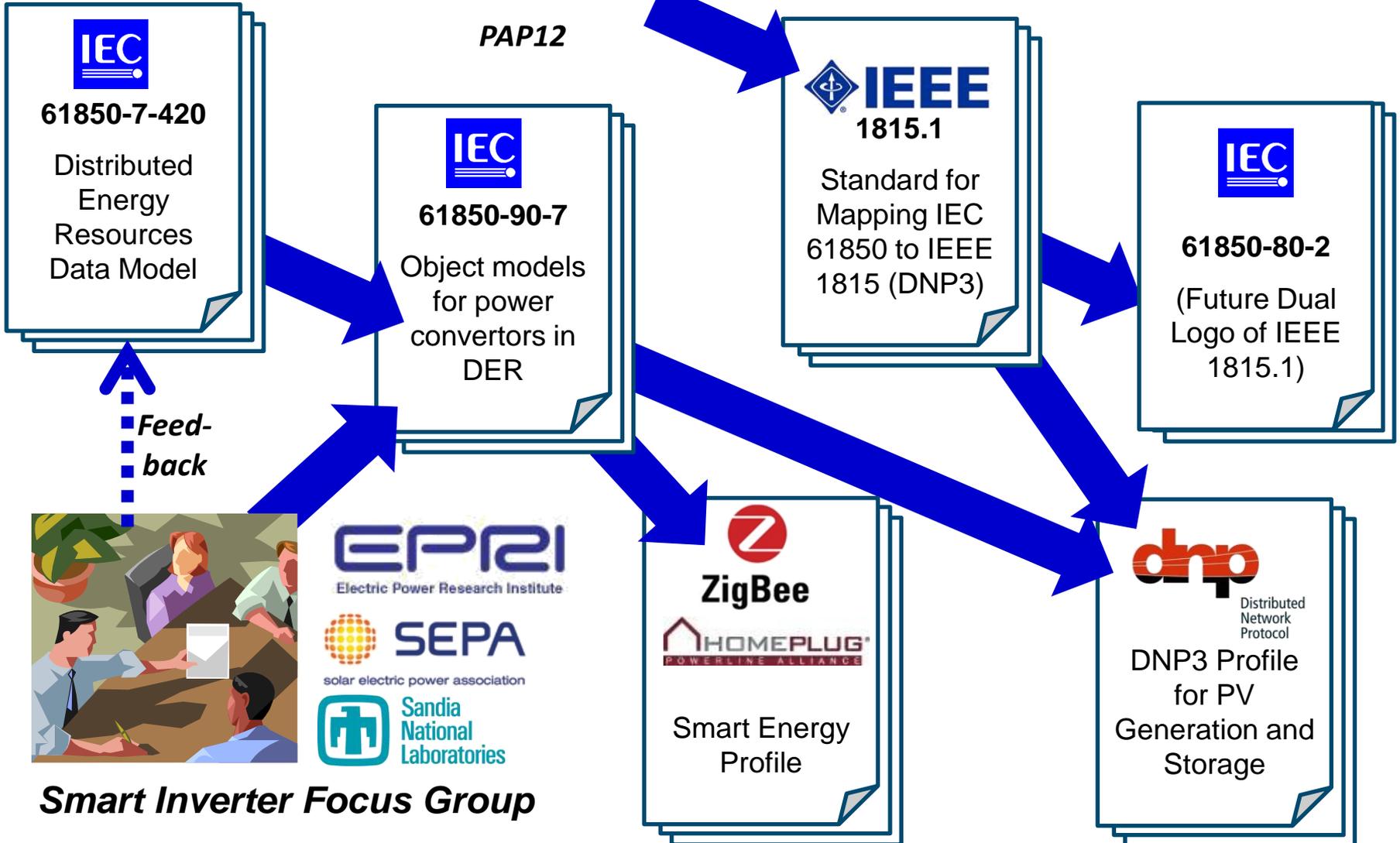
- Distributed generation systems increasing in popularity
- Need a standard way to communicate with the utility
- Need to agree on a common operating model
 - What should a system be able to do?
 - What data should be made available?
 - How should generation interact with storage?
 - What equipment should be modeled?
 - What protocol(s) should it use?



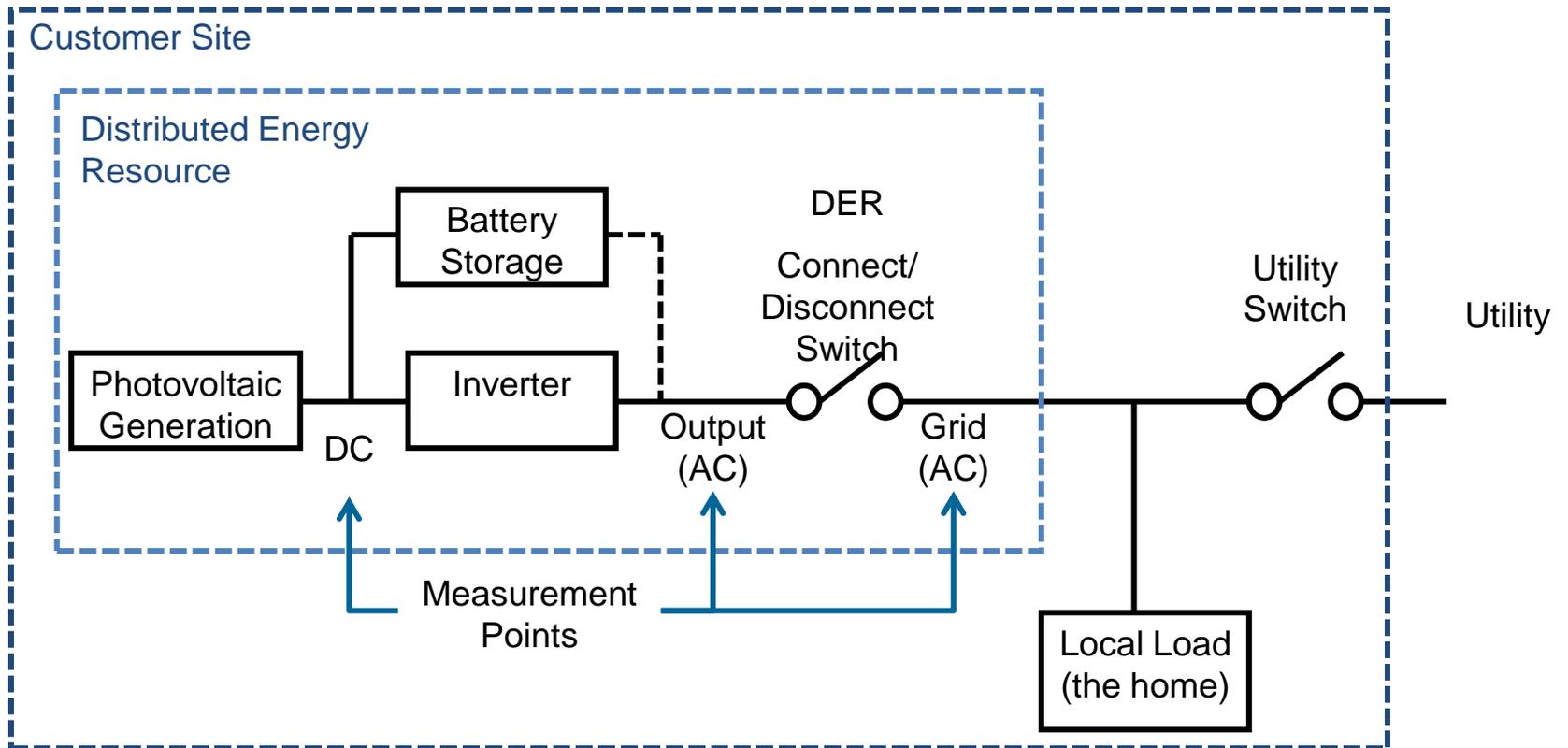
Developing the Standards

SGiP

PAP12



Model DER System



DER Generation & Storage Functions - Basic

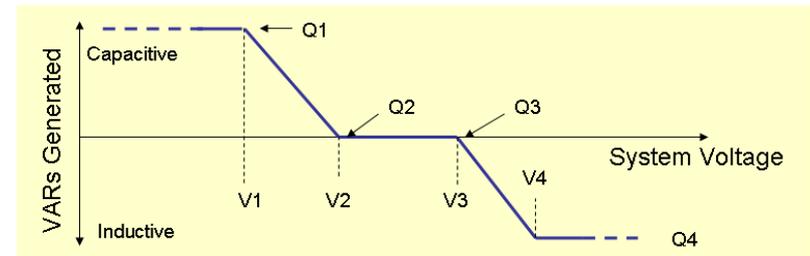
- Connect or disconnect from grid
- Adjust maximum generation level
- Adjust power factor
- Charge or discharge storage
- Act on pricing signal
- Modify settings
- Log event history
- Report status
- Follow Volt/VAR curves
- Schedule changes in curve or settings

Mode PV1 – Normal Energy Conservation Mode

Example Settings

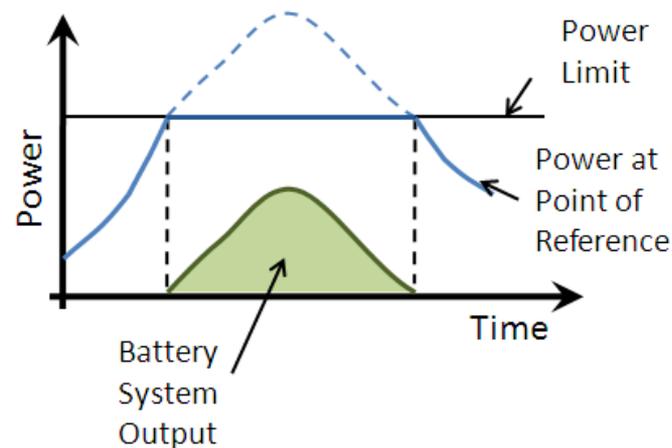
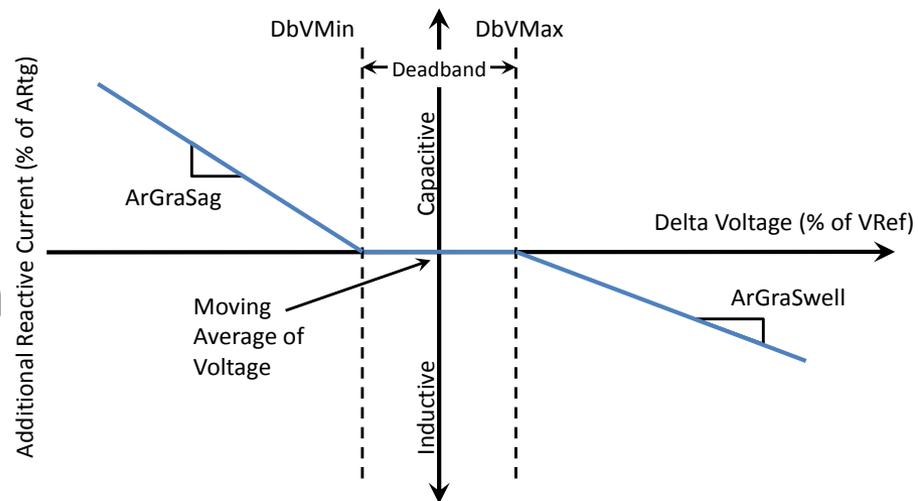
Voltage Array		VAR Array (%)	
V1	115	Q1	100
V2	118	Q2	0
V3	122	Q3	0
V4	126	Q4	-100

VAR Ramp Rate Limit – fastest allowed change in VAR output in response to either power or voltage changes	50 [%/second]
Randomization Interval – time window over which mode or setting changes are to be made effective	60 seconds



DER Generation & Storage Functions - Advanced

- Frequency-Watt curve
- Dynamic reactive current
- Low/High voltage ride-through
- Watt-Power factor curve
- Volt-Watt curve
- Temperature-VAR curve
- Real power smoothing
- Dynamic Volt-Watt mode
- Peak power limiting
- Load and generation following



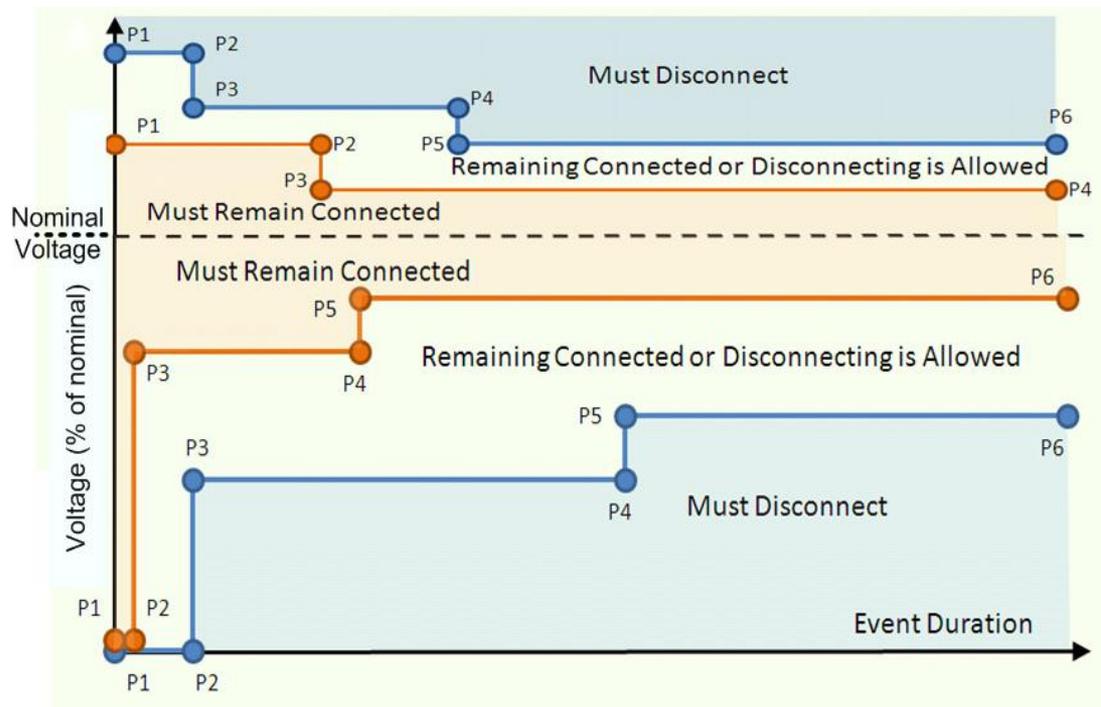
Interactions Between Functions

- The standards define how all these functions interact
- Some functions cannot run simultaneously
- Some can override the others
- Factors affecting which function is operating:
 - Physical limits, e.g. no wind or sun
 - Nameplate limits, e.g. maximum storage capacity
 - Chosen operating limits
 - Transient vs. Steady-state functions
 - Commanded vs. Automatic vs. Scheduled
 - Local/Remote mode
 - Automatic/Manual mode



Low/High Voltage Ride-Through

- Configurable curves, multiple zones
- This kind of flexibility not currently permitted by IEEE 1547
- Must be configured to comply



DNP3 Photovoltaic Profile



- Official DNP3 Application Note
- Published on DNP Users Group web site
- Specifies required protocol Options
- Mapping to the DER smart inverter functions
- Mapping to IEC 61850-90-7 Object Model
- Minimum points list
- Std. data formats

2.2.3 Binary Inputs

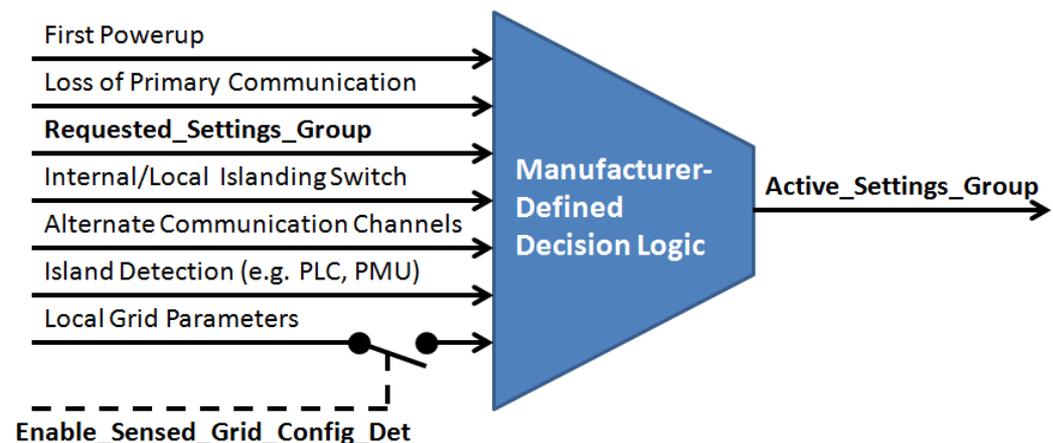
Table 4 lists the binary input points to be used in the DNP3 Profile for Photovoltaic Generation and Storage Systems. Table 5 specifies the options to be used by outstations in reporting these points

Table 4 – Binary Input Points List

Point Index	Name / Description	Default Event Class	Name for State when value is 0	Name for State when value is 1	IEC 61850			
					LN Class	LN Inst	Data Object	CDC
0	Mode of operation – limited Watts	2	Disabled	Enabled	DOPM	2	OpModWLim	SPC
1	Mode of operation – fixed powerfactor	2	Disabled	Enabled	DOPM	3	OpModPFAn	SPC
2	Mode of operation – charge/discharge rate	2	Disabled	Enabled	DOPM	4a	OpModWRte	SPC
3	Start PV generation	2	Null	Started	DRCC	1	DERStr	SPC
4	Stop PV generation	2	Null	Stopped	DRCC	1	DERStop	SPC
5	Set automatic mode	2	Not Auto	Auto	DRCC	1	AutoManCtl	SPC
6	Set local/remote control mode	2	Remote	Local	DRCC	1	LocRemCtl	SPC
7	PV system is in automatic mode	3	Not-Auto	Auto	DRCS	1	AutoMan	SPS
8	PV is generating and connected	3	Null	On-Connected	DRCS	1	ModOnConn	SPS
9	PV is generating and available for connection	3	Null	On-Not-Connected	DRCS	1	ModOnAval	SPS
10	PV is off but available to start generating	3	Null	Off-Available	DRCS	1	ModOffAval	SPS
11	PV is off and not available to start generating	3	Null	Off-Not-Available	DRCS	1	ModOffUnav	SPS
12	VAR management capability	3	No VAR Mgmt	VAR Mgmt Available	DRCS	1	ModVAR	SPS
13	Inverter active power output too high	1	Normal	Alarm	MMXU	1	TotW.range	MV
14	Inverter active power output too low	1	Normal	Alarm	MMXU	1	TotW.range	MV
15	Inverter reactive output too high	1	Normal	Alarm	MMXU	1	TotVAr.range	MV
16	Inverter reactive output too low	1	Normal	Alarm	MMXU	1	TotVAr.range	MV
17	Current output frequency	1	Normal	Alarm	MMXU	1	Hz.range	MV

Grid Configuration and Islanding

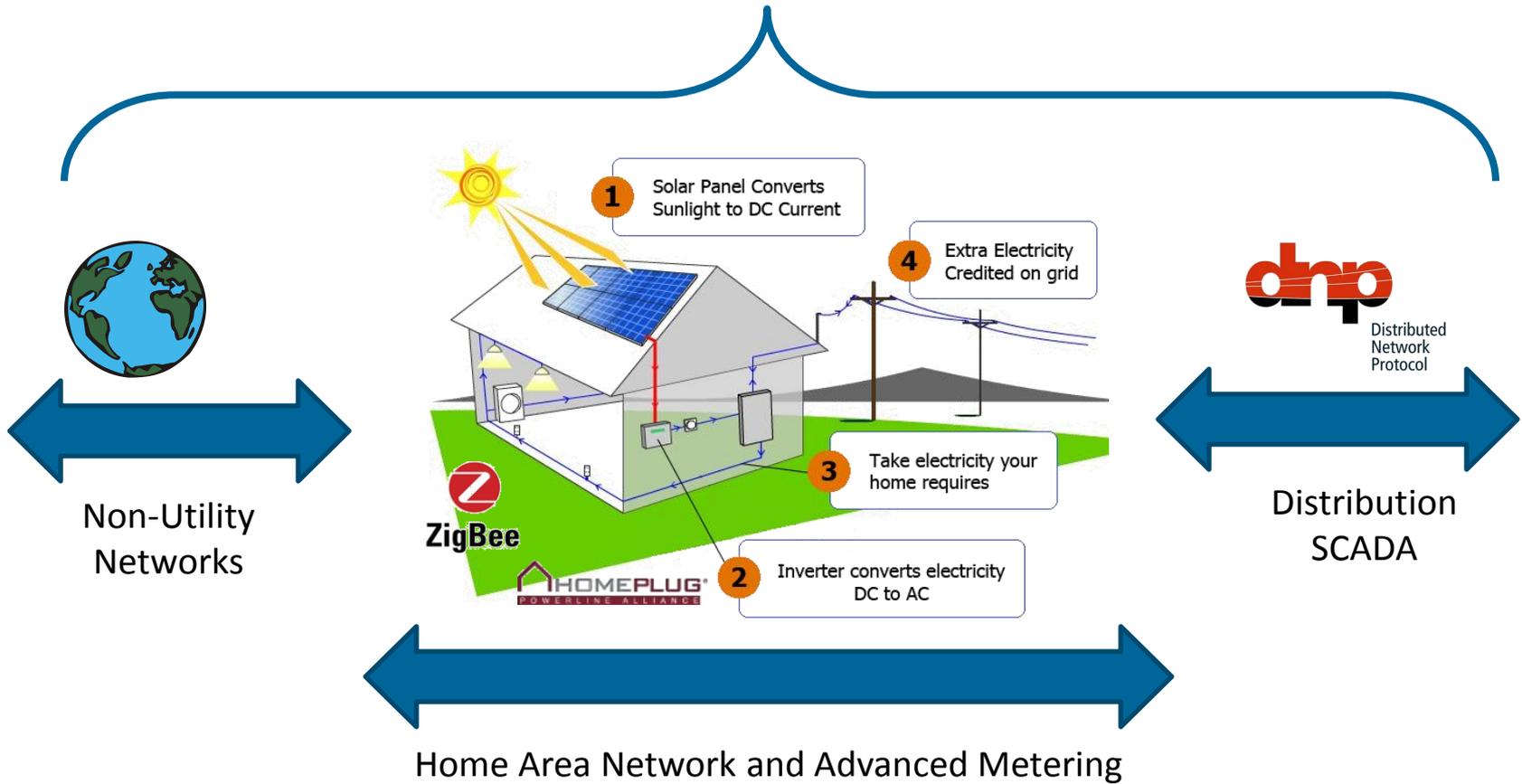
- The role of the DER may change
 - Islanded or not islanded
 - Site controller or not site controller
 - Communicating or not communicating
 - Other factors
- The standards define multiple settings groups
- The DER chooses which settings group to use on the fly



Results



Consistent Behavior and Responses



Questions?

E n e r N e x

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

Grant Gilchrist, EnerNex

grant@enernex.com

403-938-0220

Brian Seal, EPRI

bseal@epri.com