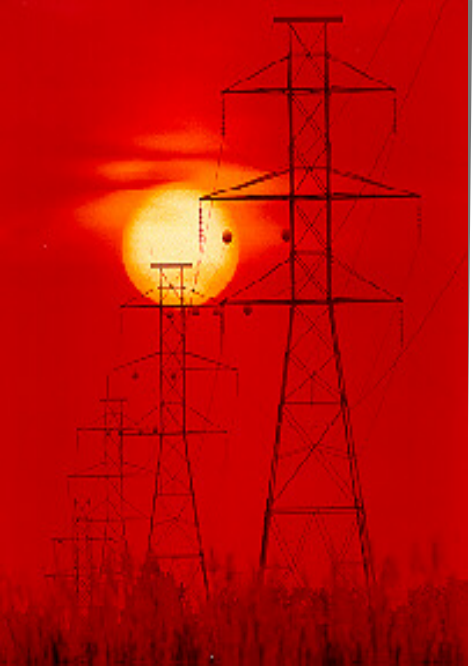

# SIWG Phase 3 Workshop

10:00 am, September 25, 2015

*Frances Cleveland*

*fcleve@xanthus-consulting.com*

Xanthus
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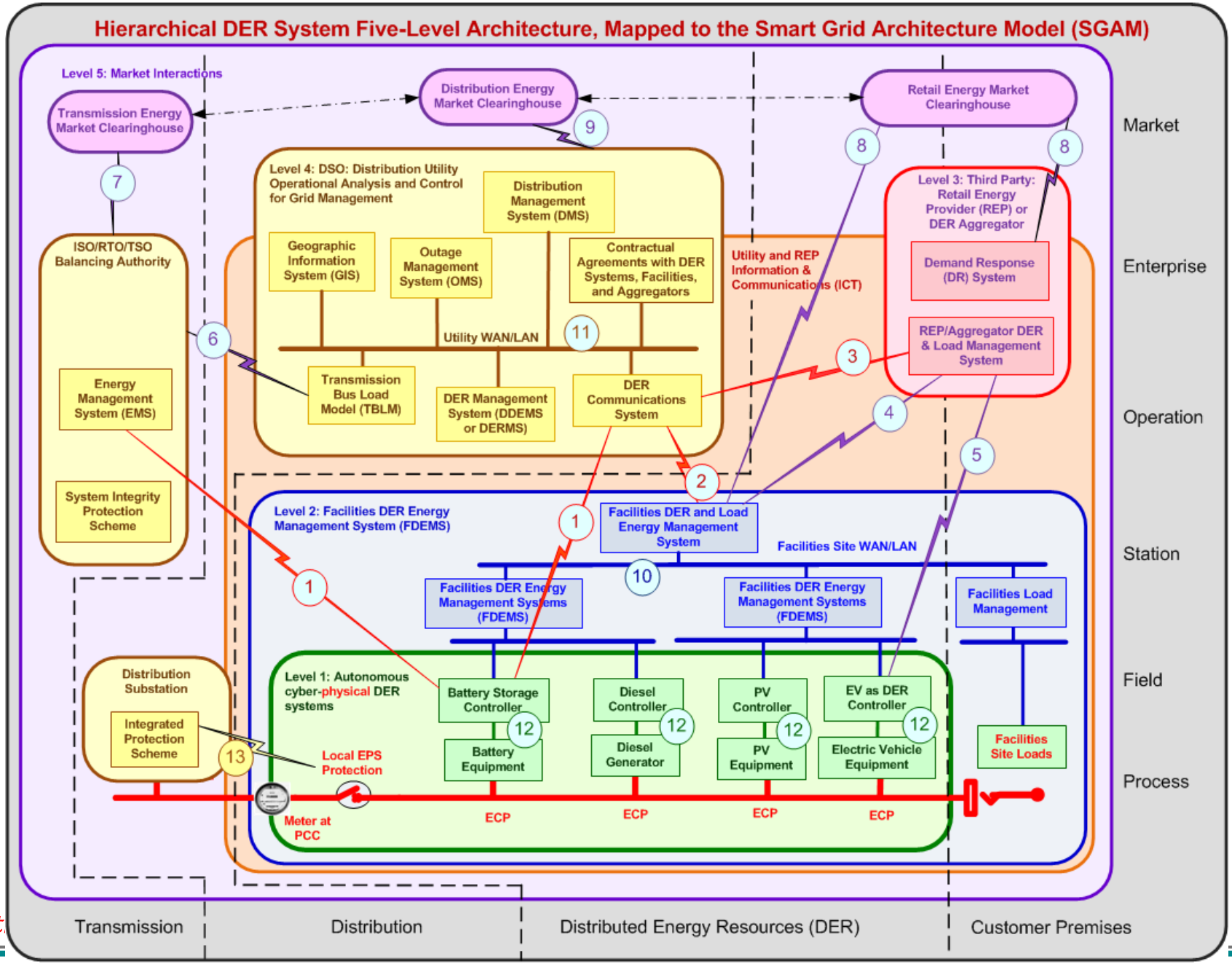
# Hierarchical Structure of DER Interactions



# Possible Use Cases for SIWG DER Functions Generation, Storage, and/or Controllable Load (IDSR) – Probably Entails Compensation

- Real-time operations (now and expected within 5-10 years from now)
  - Manage, limit, and/or curtail real power to avoid or mitigate distribution congestion, equipment overloads, or power quality issues
  - Manage, limit, and/or curtail real power to avoid or mitigate transmission congestion, equipment overloads, or power quality issues
  - Schedule real power (ESS or other DER)
  - Provide “available” reactive power for power quality voltage support on a feeder (no impact on real power)
  - Provide maximum reactive power for reliability voltage support on a feeder (does impact real power)
  - Provide reactive power for transmission voltage support near a substation
  - Provide operational (spinning and non-spinning) real power reserves (normal operations and microgrids)
  - Provide AGC frequency support through direct utility control (ESS with CAISO)
  - Provide autonomous frequency support (Frequency-Watt) (CAISO)
  - Compensate for renewable energy fluctuations (ESS with PV/wind)
  - Compensate for (rapid) load fluctuations (DER/ESS with loads)
  - Reduce peak loads (demand response)
  - Create (planned) islanded microgrid
  - Provide black start capabilities

# DRP-Related Use Cases for SIWG DER Functions Generation, Storage, and/or Controllable Load

- Planning (Not in current DRPs, but may be in DRPs down the road)
  - Generation capacity for resource adequacy and flexibility
    - Efficiency purposes (e.g. Duck curve)
    - Emergency purposes (e.g. Operational reserves)
  - Locational real power management
  - Voltage management requests for distribution locations
  - Voltage management requests by CAISO
  - Frequency management requests by CAISO
- What is feasible and available today? What might have longer term benefits?
  - Need to prioritize the Use Cases

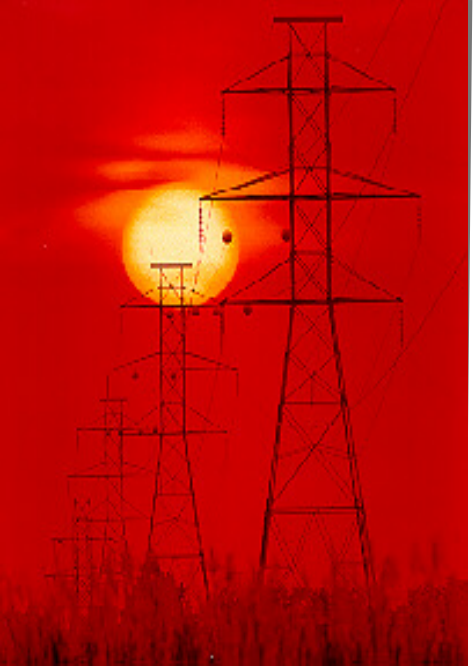
# DER Market Issues: Policies and Technologies

- Should generation, energy storage, and (controllable) load be considered separately or as part of “DER systems”?
  - Behind-the-meter energy storage?
  - Different market programs for load (e.g. demand response)?
  - Should electric vehicles be included as DER?
- What are the market structure “primitives”?
  - Tariffs/contracts for requesting certain functions for x hours per year
  - Open requests (demand response) for functions at specific times for $
  - Transactive energy bid/offer processes
- Should there be separation in what “wires utilities” vs. “generators” vs. “aggregators” can own, manage, and/or bid into the market? Or does that cause unfair market situations?
- How can gaming of the market be avoided?
  - For example, an entity managing energy storage systems deliberately increases their load (charging) in one location and then is paid to decrease their load (discharging) – particularly if locational pricing benefits one location over another?

# Texas: Example of Possible DER Market Strategies

***Distributed Resource Energy & Ancillaries Market (DREAM) Task Force***

| Features | DER Minimal | DER Light | DER Heavy |
|---|---|---|---|
| Energy Settled at: | Load Zone SPP | Price at Local electrical bus(es) | Logical Resource Node (price at Local electrical bus(es)) |
| Energy Market Participation | Self-responding | Self-responding | SCED-dispatched |
| Ancillary Service Market Participation | Not eligible | Not eligible | Eligible |
| Aggregation Allowed? | N/A | Yes | Yes |
| Metering Required | Single meter OK (15-minute revenue quality) at POI | Separate (dual) metering for Generation and native Load | Separate (dual) metering for Generation and native Load |
| Telemetry or telemetry-light to and from ERCOT | Not required | Real-time or near real-time with multiple attributes | Real-time or near real-time with multiple attributes |
| COP, Outage Schedule, Offers/Bids, etc. | N/A | Possible "light" version required | Required |
| CRR/PTP Implications | None | None | Yes |



# SIWG Phase 3 Panel Session

2:30 pm, September 25, 2015

*Frances Cleveland*

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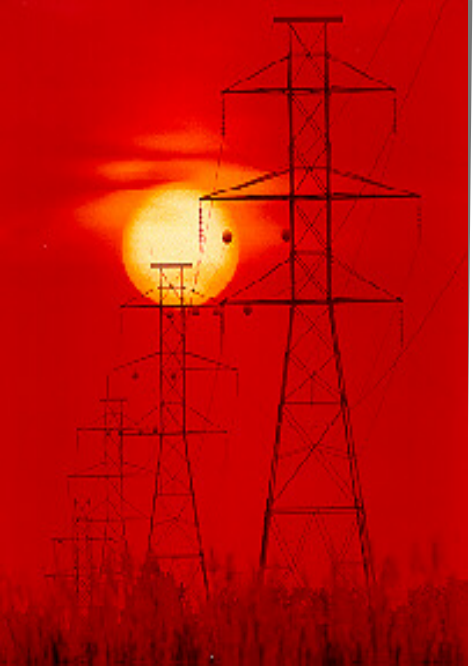
# Functions in Phase 3 Document – May Entail Compensation

- **Monitor DER Status and Output**: Provide status and measurements on current energy and ancillary services (Section 3 – more complete details in Phase 2)
- **Command DER to Connect or Disconnect**: Support direct command to disconnect or reconnect (Section 4)
- **Limit Maximum Real Power**: Limit maximum real power output at an ECP or the PCC upon a direct command from the utility (Section 5)
- **Set Real Power**: Set actual real power output at the ECP or export/import level at the PCC or at some virtual point (Section 6)
  - ***Set Energy Storage charge and discharge rates (could be Automatic Generation Control):*** a variation of the set real power function (Section 7)
  - ***Load and generation following***: a variation of the set real power function (Section 8)
  - ***Real power smoothing***: a variation on load and generation following (Section 9)
  - ***Set Storage Ramp Rate***: Apply ramp rates to the charging and discharging of energy storage systems (similar to Phase 1 Set Ramp Rates)
- **Frequency-Watt**: Counteract frequency excursions beyond normal limits by decreasing or increasing real power (Section 10)
  - ***Storage Frequency-Watt***: Vary active power to counter frequency changes (Section 10)
- **Voltage-Watt:** Modify real power output autonomously in response to local voltage variations (Section 11)
  - Dynamic Volt-Watt provides a voltage stabilizing function (Section 12)
- **Dynamic Reactive Current Support**: Counteract voltage excursions beyond normal limits by providing dynamic current support (Section 13)
- **Scheduling** settings and modes (Section 14)
- DER Functions “Also Important” to DER Integrators and Other Third Parties (Section 15)
  - Other?

# Phase 3 DER Mandatory/Optional Functions (Draft!!)

| SIWG Phase 3 DER Functions<br>May entail compensation | Capability is mandated and enabled by default | Capability is mandated but not enabled by default | Capability is optional, but IF implemented, THEN it should be compliant with the Phase 3 document |
|---|---|---|---|
| Monitor DER Status and Output: (Section 3) | | Yes | |
| Command DER to Connect or Disconnect: (Section 4) | | Yes | |
| Limit Maximum Real Power: (Section 5) | | | Yes |
| Set Real Power: (Section 6) | | Yes | |
| Set Energy Storage charge and discharge rates: (Section 7) | | Yes (for ESS) | |
| Load and generation following: (Section 8) | | | Yes |
| Real power smoothing: (Section 9) | | | Yes |
| Set Storage Ramp Rates: (Phase1) | | | Yes (for ESS) |
| Frequency-Watt: (Section 10) | | Yes | |
| Storage Frequency-Watt: (Section 10) | | Yes (for ESS) | |
| Voltage-Watt: (Section 11) | | Yes | |
| Dynamic Volt-Watt (Section 12) | | | Yes |
| Dynamic Reactive Current Support: (Section 13) | | Yes | |
| Scheduling settings and modes (Section 14) | | | Yes |



# Additional Slides

# SIWG Economic and Technical Use Cases vs. DRP's *Mutually Exclusive and Collectively Exhaustive* List

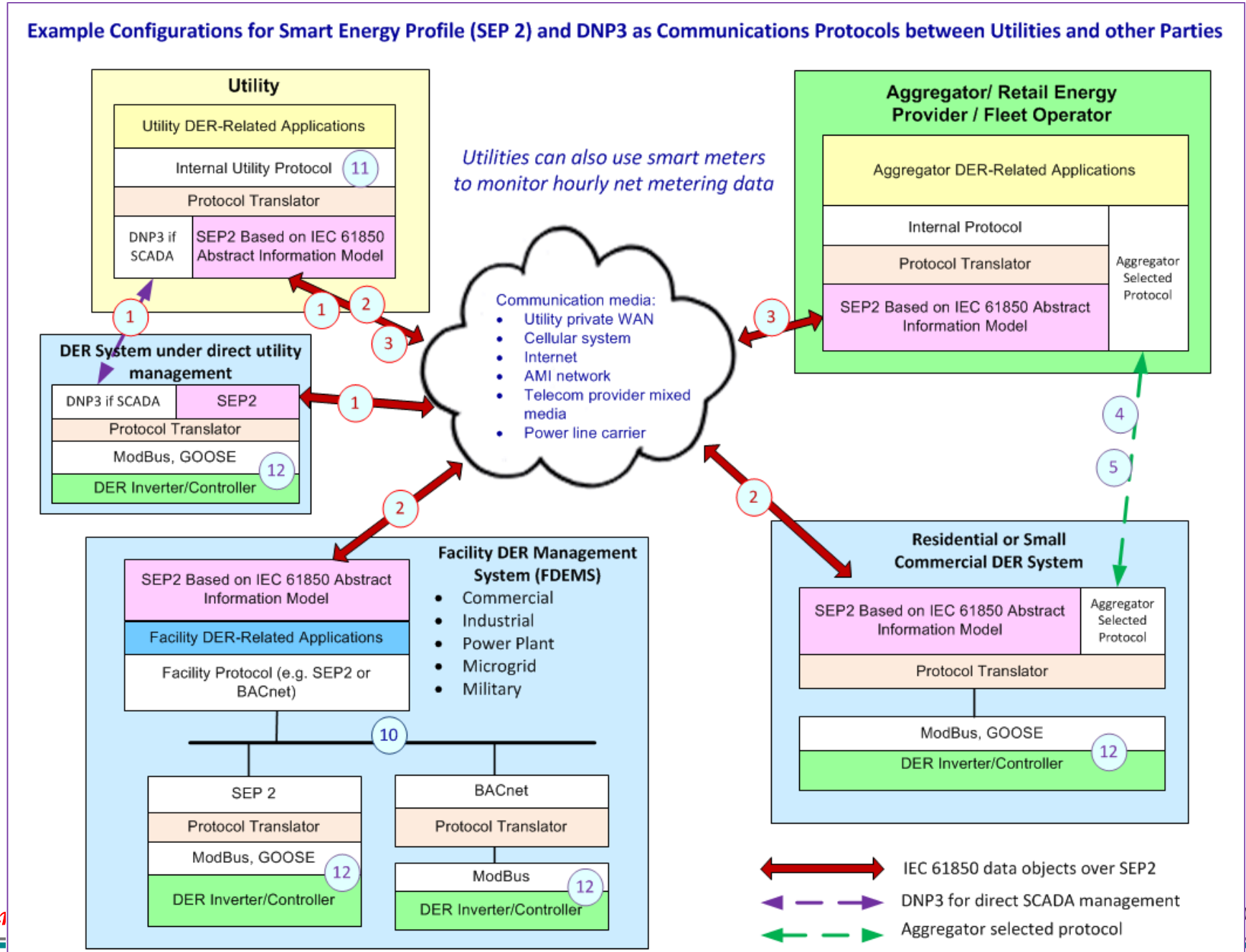
| SIWG Economic and Technical Use Cases for Smart DER Functions, Categorized by the DRP's More-Than-Smart "*Mutually Exclusive and Collectively Exhaustive (MECE)*" List | Utility Actions | | | | | | | | | | | DER or PCC Autonomous Modes | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Static | | Monitoring | | | | Controlling | | | | | Real Power | | | | | | | PF | | Freq. Support | | | | Voltage Support | | | | | Resilience | | |
| | Access: DER and/or PCC nameplate data | Access: DER/PCC capabilities and supported modes | Monitor: DER and/or PCC operational characteristics | Monitor: Short term forecast of DER/PCC energy | Monitor: Permitted/available DER/PCC modes | Monitor: DER and/or PCC status & measurements | Control: Start/stop DER | Control: Enable/disable modes of DER/PCC | Control: Set mode parameters and curves for DER/PCC | Control: Schedule real power and modes of DER/PCC | Control: Issue AGC Reg Up and Down | Mode: Limit maximum DER real power output | Mode: Limit maximum ESS charging rate | Mode: Set real power output of DER or at PCC | Mode: Set real power (dis)charging rate of ESS or at | Mode: Load / generation following by DER or ESS | Mode: Smoothing of real power spikes and sags | Mode: Soft-Start Reconnection | Mode: Fixed power factor | Mode: Power factor correction | Mode: High/low frequency ride-through or trip | Mode: AGC (utility sends Reg up and down commands) | Mode: Frequency smoothing (rapid frequency deviations) | Mode: Frequency-watt (Emergency) | Mode: High/low voltage ride-through or trip | Mode: Volt-var control | Mode: Volt-watt control (autonomous) | Mode: Fast var support | Mode: Dynamic reactive current support | Mode: Backup power | Mode: Provide black start | Mode: Convert into microgrid |
| **ISO/RTO Balancing Authority & Market** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Resource Adequacy (Capacity, Generation, Bl. Start) | x | x | | | | | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | |
| Resource Adequacy (Flexibility, Ramping, Market) | x | x | | | | | | | | | x | x | x | x | x | x | x | x | | | x | x | | | | x | x | x | x | x | x | x |
| Variable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Energy (shifting in time) | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | | | | | | | | | | | | | | | | |
| Frequency regulation | x | x | x | x | x | x | | x | x | | x | | | | | | | | | | x | x | | x | | | | | | | | |
| Frequency smoothing | x | x | x | x | x | x | | x | x | | | | | | | | | | | | | | x | | | | | | | | | |
| Spinning reserve | x | x | x | x | x | x | | x | x | | | | | x | x | x | | | | | | | | x | | | | | | | | |
| Non-spinning reserve | x | x | x | x | x | x | | x | x | | | | | x | x | x | | | | | | | | | | | | | | | x | x |
| **Transmission Operations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Upgrade deferral due to congestion mitigation | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x |
| Variable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transmission voltage support | x | x | x | x | x | | x | x | x | x | | | | | | | | | x | x | | | | | x | x | x | x | x | | | |
| Transmission congestion relief | x | x | x | x | x | | x | x | x | x | | x | x | x | x | x | | | | | | | | | | | | | | | | |
| Efficiency (loss reduction) | x | x | x | x | x | | x | x | x | x | | | | | | | x | | | | | | | | | | | | | | | |
| Reliability (redundancy, inertia) | x | x | x | x | x | | x | x | x | x | | x | x | x | x | x | x | x | | | x | | | x | x | x | x | x | x | x | x | x |
| **Distribution Operations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Upgrade deferral due to load levels & patterns | x | x | | | | | | | | | | x | x | x | x | x | x | x | | | | | | | | x | x | | | | | x |
| Variable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Provide distribution voltage support | x | x | x | x | x | x | x | x | x | x | | | | | | | | | x | x | | | | | x | x | x | x | x | | | |
| Maintain CVR | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | x | x | x | | | | |
| Reduce number/duration of outages | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | x | x | x | x | x | x | | | |
| Improve power quality (spikes, harmonics) | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | x | x | x | x | x | | | |
| Improve efficiency | x | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x | x | | | | | | | x | x | x | x | x | | | |
| Avoid equipment overload, loss of life | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | x | x | x | x | x | | | |
| Improve equipment life | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | x | x | x | x | x | | | |
| Support safety | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | x | | | | x | | | | | | | |
| **Customer/End User** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fixed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Procurement risk mitigation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Variable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Support customer choice | | x | x | x | x | x | x | x | x | x | | | x | | x | x | x | | x | x | | x | x | x | | x | x | x | | x | x | x |
| Reduce energy costs | | x | x | x | x | x | x | | | | | x | x | x | x | x | | | | | | | | | | | | | | | x | x |
| Improve power quality (spikes, harmonics) | | | | | | | | | | | | | | | | | | | x | x | | | x | x | | x | x | x | x | | | |
| Avoid equipment damage | | | x | | x | x | x | | | | | | | | | | | | | | x | | | | x | | | | | x | | x |
| Support safety | | x | x | | x | x | x | | | | | | | | | | | | | | x | | | | x | | | | | x | | x |
| Improve reliability (microgrids, backup power) | | x | x | | x | x | x | | | | | | | | | | | | | | | | | | | | | | | x | | x |
| Price & performance risk mitigation | | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Societal** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Variable | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reduce CO2 emissions | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reduce pollutants | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve energy security | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve water usage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve land usage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Improve economy | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Complete Set of Functions Identified by SIWG

| Phase | Function # | Function |
|---|---|---|
| 1 | 1 | Mode: Anti-islanding |
| 1 | 2 | Mode: High/low voltage ride-through or trip |
| 1 | 3 | Mode: High/low frequency ride-through or trip |
| 1 | 4 | Mode: Volt-var control |
| 1 | 5 | Mode: Fixed power factor |
| 1 | 6, 21b | Settings: Ramp rates (including for ESS) |
| 1 | 7 | Mode: Soft-Start Reconnection |
| 2 | 3 | Settings: Enable/disable modes of DER at ECP or up to PCC |
| 2 | 3 | Settings: Set mode DER parameters and curves at ECP or up to PCC |
| 2 | 3 | Monitor: DER status & measurements at ECP or up to PCC |
| 2 | 3 | Monitor: DER operational characteristics at ECP or up to PCC |
| 2 | 3 | Monitor: Permitted/available DER modes at ECP or up to PCC |
| 2 | 3 | Access: DER/PCC capabilities and supported modes |
| 2 | 30, 31 | Access: DER and/or PCC nameplate data |
| 3 | 4 | Mode: Limit maximum DER real power output |
| 3 | 4a | Mode: Limit maximum ESS charging rate |
| 3 | 5 | Mode: Set real power output of DER or up to PCC |
| 3 | 6 | Control: Connect/disconnect DER at ECP or up to PCC |
| 3 | 7 | Mode: Frequency-watt (Emergency) |
| 3 | 8 | Mode: Volt-watt control (autonomous) |
| 3 | 9 | Mode: Dynamic reactive current support |
| 3 | 21 | Mode: Set real power (dis)charging rate of ESS |
| 3 | 22 | Mode: Frequency-watt (ESS) |
| 3 | 23, 25 | Schedule: real power of DER at ECP or up to PCC |
| 3 | 26 | Schedule: modes of DER at ECP or up to PCC |
| 3 | 27 | Monitor: Schedules of DER at ECP or up to PCC |
| 3 | 36 | Mode: Load / generation following by DER or ESS |
| 4 | 10 | Mode: Watt-Power factor |
| 4 | 10a | Mode: Power factor-Power factor (IEEE 1547?) |
| 4 | 10b | Mode: Power factor correction (modify ECP PF to correct PCC PF) |
| 4 | 11 | Mode: Frequency-watt smoothing for mitigating rapid frequency deviations |
| 4 | 12 | Mode: Volt-var response to weather, etc. |
| 4 | 14 | Use Case: Provide black start after outage |
| 4 | 15 | Control: Issue AGC Reg Up and/or Down |
| 4 | 16 | Use Case: Provide spinning reserve |
| 4 | 17 | Control: Provide reactive power support during non-generation times |
| 4 | 19 | Mode: Fast var support for mitigating rapid voltage deviations |
| 4 | 20 | Mode: Backup power for facility |
| 4 | 24 | Mode: Flow reservation (ESS, e.g. EV) |
| 4 | 28 | Monitor: Short term forecast of DER/PCC energy |
| 4 | 29 | Monitor: Micro-locational weather forecasts: |
| 4 | 34 | Use Case: DER performs configuration assessment |
| 4 | 35 | Control: Convert into microgrid and operate as microgrid |
| 4 | 36a | Mode: Smoothing of real power spikes and sags |
| 4 | 39 | Market: Respond to real power pricing signals |
| 4 | 40 | Market: Respond to ancillary services pricing signals |

- IEEE 2030.5 Communications Implementation Guidelines to include Phase 1, Phase 2, and Phase 3 functions
  - “Mode” is autonomous actions
  - “Settings” sets parameters
  - “Monitor” reads information
  - “Control” issues a command
  - “Schedule” involves scheduling actions
  - “Access” may be offline
  - “Use Case” is a more complex application
  - “Market” is a market interaction
- Phase 3 functions to be included in Phase 3 document
- “Phase 4” are lower priority functions which are not expected to be covered at this time, but may be implemented for special circumstances

# DER Configurations, SEP2, DNP3, and Other Protocols



# DER Hierarchical Levels 1-4 (without market)