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Power Systems
Engineering Center

Recommendations for Interoperability of Distributed PV Power Systems

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Presentation Outline

- Definition and scope of DER (PV) Interoperability
- Stakeholders & applications
- Examples of M&C requirements (summary of interviews with non-NYS JU utilities)
- Recommendations considering implications of NY REV and future coordination with bulk power

Impact of NY REV

Solar Power (in Megawatts) and Projects Installed by Region Pre-NY-Sun and Under NY-Sun

Region	Total Installed Through 2011		Total Installed Through 2016		% MWs Increase	% Projects Increase
	MWs Installed	Projects Installed	MWs Installed	Projects Installed		
Capital Region	9.91	991	113.26	8,365	1,043%	744%
Central New York	1.75	185	23.56	1,731	1,246%	836%
Finger Lakes	2.36	266	37.38	1,870	1,487%	603%
Long Island	38.26	4,756	214.23	24,428	460%	414%
Mid-Hudson	12.88	1,353	162.74	14,125	1,164%	944%
Mohawk Valley	1.59	162	26.95	1,790	1,597%	1,005%
New York City	7.35	404	88.42	7,348	1,102%	1,719%
North Country	1.51	200	13.98	1,063	827%	432%
Southern Tier	2.28	402	29.23	2,113	1,182%	426%
Western New York	5.18	360	33.88	2,093	554%	481%
Total	**83.06**	**9,079**	**743.65**	**64,926**	**795%**	**615%**

Residential/small commercial (35%), commercial/industrial (50%), competitive PV (15%)

https://www.nyserda.ny.gov/solarcapacity

Recommendations

1. Consider future (REV-desired) state & configuration of electric system (DSP platform)
2. Consider roles & responsibilities of stakeholders (utility, DER operators/aggregators, bulk system operators)
3. Develop methods for collaborating & exchanging data among stakeholders to avoid duplication of effort and equipment
4. Develop capabilities in modeling & simulation to support field measurements (for load & generation)
5. Revise SIR to indicate & provide technical justification for interoperability at appropriate levels

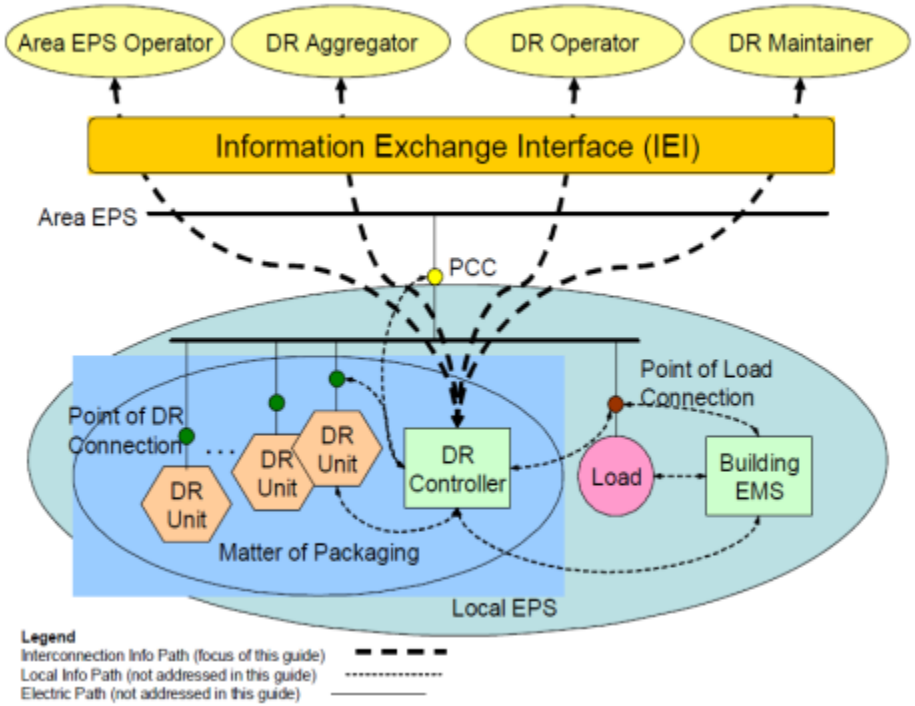
Presentation Terms – Scope of Discussion

- **Interoperability** - The capability of two or more networks, systems, devices, applications, or components to externally exchange and readily use information securely and effectively.
- **Measurement (typ. Metering)** – means of determining the energy production (kWh) of DER over time (e.g. monthly meter reads, 15 minute AMI data), newer systems may include other parameters
- **Monitoring** – near real-time methods that communicate system status, output level (kW), etc., to the utility and possibly others
- **Control** – direct utility control of a load-break element inline with DER grid connection (may include protection)
- **Adv. Control** – control of the DER/plant directly using externally derived set points to meet specific control objectives

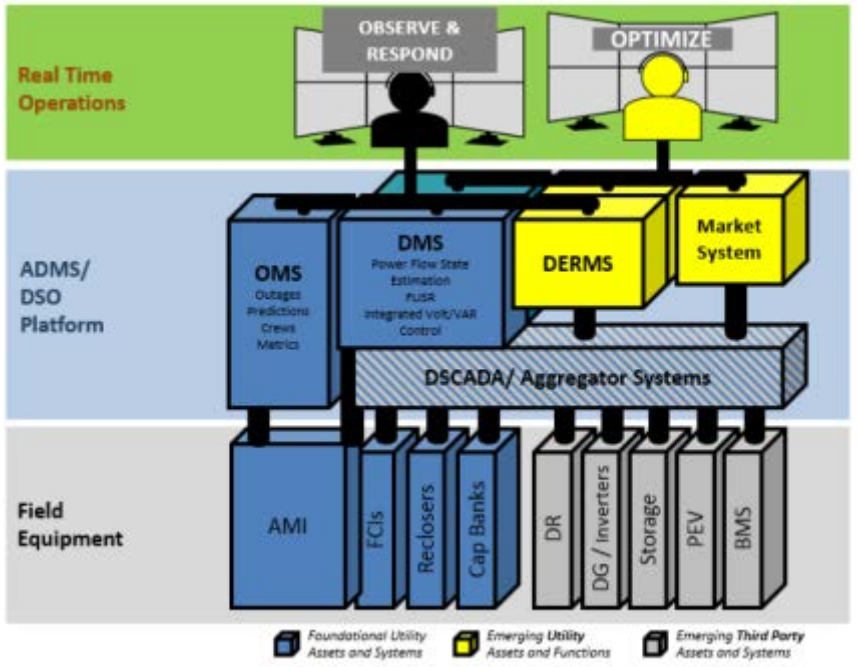
The Value of Interoperability

- Measurements
  - Metering (15 minute intervals, kWh)
  - Other measurements (some metering systems may provide additional parameters such as voltage & reactive power)
  - Measurements at key locations will provide information for modeling & simulation software
- Monitoring (typ. at PCC), near real-time
  - Supports Dist. Planning, Dist. Operations, ADMS, DSP,
- Control & advanced control
  - Supports Dist. Operations, high pen. DER scenarios, DSP, aggregation – grid services
- Modeling & Simulation

Stakeholders & Interoperability



IEEE 1547.3 Reference diagram for information exchange (source: IEEE 1547.3)



"Enabling Technologies" – JU supplemental DSIP, Nov 1, 2016

http://jointutilitiesofny.org/wp-content/uploads/2016/10/3A80BFC9-CBD4-4DFD-AE62-831271013816.pdf

Stakeholders & Essential Functions

Distribution System Operator

- planning
- operations
- protection

DER System Operators/ Aggregators

- planning
- operations
- protection

Bulk System Operator

- planning
- operations
- protection

Results from Interviews with non-NYS JU Utilities

- Six utilities gave responses (APS, SCE, Pepco, HECO, TEP, Xcel)
- Monitoring & control requirements differed widely
  - APS – AMI production meters for all systems, telemetry at 1 MW (potential to go down to 400 kW for campuses)
  - Pepco – metering threshold is at 2MW by state rules
  - SCE – telemetry (real & reactive power) threshold is at 1MW
  - TEP – no monitoring or control for < 50kW, engineering study after that
  - Xcel – currently telemetering required for ≥ 1MW, may go to 250kW in future, some control already for ≥ 5MW

Results from Non-NYS JU Utility Interviews

- Main Concerns
  - Performance (top issue)
  - Monitoring & control capability
  - Standardization and costs
  - Improved situational awareness
  - Cybersecurity

- Communications Options
  - Wireless/cellular
  - **AMI**
  - Other options (public switched telephone network, IWR, radios for mesh, several pilots underway)

Summary of NERC DERTF Report (Feb 2017)

- DER and potential risks to reliability
  - Will become a concern as DER penetrations increase
  - Need more data for modeling (location, type, size, configuration, interconnection characteristics, disturbance response characteristics, operational date, DER generation profiles)
- Data and modeling needs (if DER is expected to have significant impact)
  - DER type, MVA rating, profile, operating power factor, real & reactive power control capability, PCC voltage, date of operation,
  - default equivalent impedances for various distribution grid types for input into WECC composite load model
  - DER stability models, voltage and frequency trip parameters
- Characteristics of nonsynchronous DER
  - Coordination of voltage ride-through, frequency ride-through

- **NERC DERTF Recommendations**
  - **Guidelines for modeling & assessments**, **data sharing and coordination** between distribution and transmission, **modeling** (steady-state power flow, short-circuit, dynamic disturbance ride-through, transient stability, dynamic models for DER technologies), **industry collaboration with DER vendors & modeling software vendors**

Source: NERC Distributed Energy Resources Task Force Report, Feb 2017

Modeling & Simulation Can Provide Useful Information

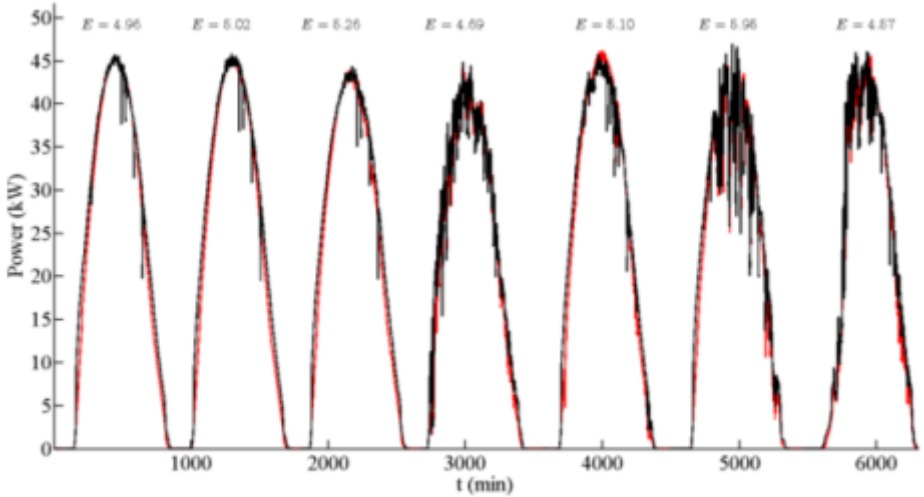
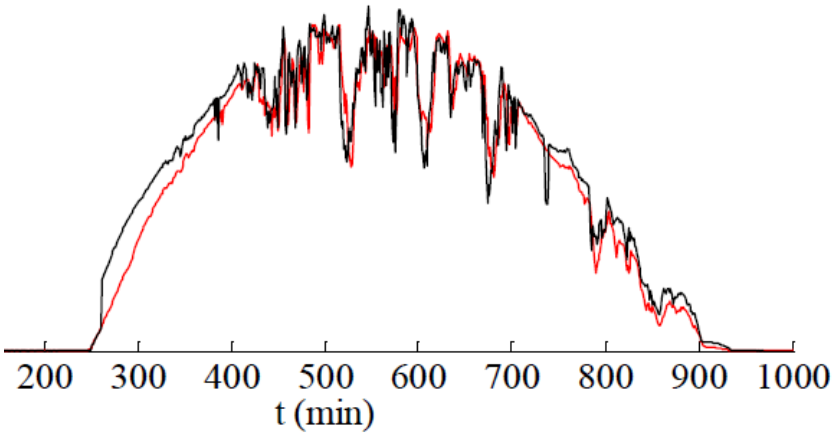


Figure 4. Time series comparison of measured (red) and derived (black) power values of the PV fleet for a week. Note that E is scaled by factor of 100.

Demonstration of estimating power of full PV fleet from a few measurements



Source: Gotseff et. all, Accurate Power Prediction of Spatially Distributed PV Systems using Localized Irradiance Measurements, 2014 IEEE PES GM conference paper

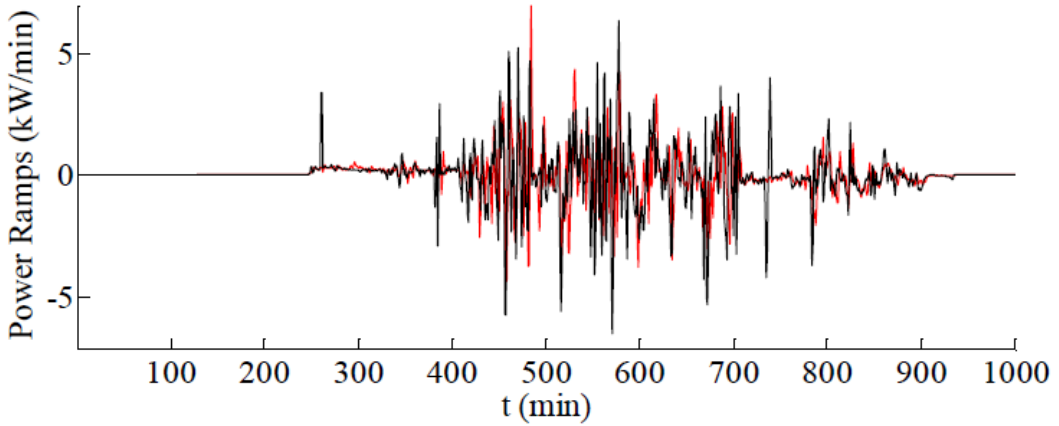


Figure 6. (a) Fleet power for a highly variable day, measured (red) and derived (black) (b) associated fleet power ramp comparison, measured (red) and derived (black).

Recommendations – considering REV

For all installations, recommend measurements at key locations to support modeling & simulation (kW, kVAr, V)

- **Small scale (< 50 kVA)**
  - Utility: modeling & simulation based on measurements, no monitoring, no control
  - DER operator: may be part of future aggregation, needing more interoperability

- **Medium scale to large scale (> 50 kVA)**
  - Future grid-supportive inverters will be able to provide voltage regulation which may be beneficial or required in some locations (autonomous functions will most likely be sufficient therefore real-time communications may not be required for smaller installations)
  - Utility: add technical guidance step in SIR to determine need for monitoring electrical parameters (stiffness ratio, impedance, etc.) & connection status, likely no control needed for most small installations (50 kVA to 300 kVA)
  - DER operator: may be part of future aggregation, supply future grid services to distribution or bulk needing more interoperability

NREL … Providing Solutions to Grid Integration Challenges

Thank You!

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