National Grid Challenge – SI Functionality and Integration into Distribution System Planning and Operations

Background

Smart Inverters (SI) go beyond basic DC-to-AC conversion to add increased control and functionality such as voltage regulation, frequency support and ride through capabilities. California's Rule 21, defines a SI as:

> *"An inverter that performs functions that, when activated, can autonomously contribute to grid support during excursions from normal operating voltage and frequency system conditions by providing: dynamic reactive/real power support, voltage and frequency ride-through, ramp rate controls, communication systems with ability to accept external commands and other functions."*

The added control and functionality of SI can also address concerns and challenges associated with integrating variable energy generation into the electric grid via sophisticated monitoring and communication of the grid status, the ability to receive offsite operation instructions, and the capability to make autonomous decisions. As stated in Rule 21, SI can support grid operation in several ways:

- *Variable power output* – support grid voltage and frequency by automatically changing power output. When coupled with energy storage, the system can also absorb power.
- *Variable power factor operation* – support grid stability, voltage regulation and reduced impact of variable generation infeed by automatically changing power factor.
- *Frequency and voltage ride-through* – stay connected and continue to provide grid support during brief disruptions.
- *Ramp rate and soft-start* – to ease transitions when changing output level or when re-connecting after a grid outage.

As described in the 2018 DSIP Update report and the Companies 5-year plans, National Grid looks to better understand the potential to integrate SI as described below:

- Continue to assess the results of an on-going effort of National Grid's affiliate in Massachusetts that is utilizing SI on its Solar Phase I-III projects
- Consider changes in the New York State Standardized Interconnection Requirements (NYSIR) to align with the latest IEEE 1547 Standard and SI controls
- Continue discussions with the Joint Utilities, research groups, and stakeholders
- Multi-tiered communications strategy and connection to DER SI
- Fruit Belt Neighborhood Solar REV Demonstration Project and PV inverter control[1]

Objective

NYSERDA and National Grid seek to collaborate with a solution provider (or team of solution providers) to evaluate and demonstrate the ability of SI to support distribution system planning and operations.

---

[1] http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={9D5268DF-77EF-42BC-8F2F-16E7F2A8D65E}

The primary grid support use case of interest is the ability to utilize and integrate SI to optimize voltage and Volt-Ampere Reactive (VAR) control on the distribution system to reduce power and energy consumption. Other SI use cases listed below may be also be considered as the project evolves:

- Increased hosting capacity/upgrade deferral – via active and reactive power control
- Grid stability – voltage and frequency ride through

SI can be used to support planning and operations to increase optimization of the future grid, however several questions remain unanswered that National Grid hopes to address in this project:

- Understand and validate SI control and communication functionality and various options:
    - Decentralized control (set and forget)
    - Centralized control via Advanced Distribution Management System(ADMS)/Distributed Energy Resource Management System (DERMS) (real time active control)
    - Hybrid control (set but don't forget) via ADMS/DERMS
- Can SI be integrated into the grid without negative side effects such as protection schemes i.e. implementation of IEEE 1547.1 testing standard once finalized (currently due 2020)
- What is the VAR drain impact on the bulk grid when SI are absorbing inductive VARS?
- How SI can be integrated with other volt/VAR control technologies:
    - Traditional volt/VAR control (fixed settings for LTC, voltage regulator and capacitor controls)?
    - Smart Grid Volt VAR Optimization (VVO)/Conservation Voltage Reduction (CVR) (optimized control of LTC, voltage regulator and capacitors through a centralized software)?
    - Secondary side volt/VAR devices?
- DG impact on distribution system volt/VAR control with and without SI
- Costs and benefits and who pays for SI volt/VAR control
- What is the value to each stakeholder?
- Potential changes to interconnection standards to allow SI control
- Cyber security concerns

National Grid recently installed a smart grid VVO/CVR project that is operational in the Clifton Park area of upstate New York, where large Distributed Generation (DG) sources plan to interconnect (see table below) at the same two stations (Elnora Street and Grooms Road) and feeders that the VVO/CVR scheme is operating. Therefore, National Grid proposes that Clifton Park is a good candidate site for this project.

All DG & Storage Projects in Queue greater than 1 MW with Planned Interconnection to Elnora Street and Grooms Road Feeders as of 9/4/19						
DG Fuel Source	**Status**	**Customer/Company**	**City**	**Total AC Rating(kW)**	**Technology Type**	**Storage**
Solar	Construction	Borrego Solar Systems, Inc	Clifton Park	5000	Inverter	No
Solar	Agreement	Borrego Solar Systems, Inc	Rexford	5000	Inverter	No
Solar	Study	New PowerCo Inc. - Eden DevCo LP	Clifton Park	4980	Inverter	No

Solar	Construction	Solitude Solar LLC	Rexford	4750	Inverter	No
Solar	Construction	Borrego Solar Systems, Inc	Ballston Lake	4000	Inverter	No
Solar	Construction	Borrego Solar Systems, Inc	Rexford	2000	Inverter	No
Solar	Study	New PowerCo Inc. - Eden DevCo LP	Clifton Park	1660	Inverter	No
Solar	Construction	General Electric International Inc	Schenectady	1350	Inverter	No

Scope of Work

Proposals should provide the following scope of work steps in sequenced order:

1. **Techno-economic system study** – Conduct offline simulations using CYME for the Clifton Park station and feeders to understand SI impacts and capabilities to support optimal volt/VAR control along with identification of estimated costs and benefits.
2. **Business case** – Based on the results from the prior step and a review of the California Rule21 and the California utility plans, develop a value based business case along with a Benefit Cost Analysis (BCA) and payment structure considering SI owner, utility[2] and any customer rate base impacts.
3. **Laboratory testing** – working with National Grid engineers, conduct the following:
    a. Identify a suitable R&D Laboratory to conduct physical testing of an applicable SI (i.e. same UL1741 SA inverter as a DG application in Clifton Park) control functionality.
    b. Establish a communication pathway to the inverter(s) utilizing National Grid's GE orbit 3/4G radio communication medium.
    c. Test protection coordination concerns.
    d. Develop or improve SI validated (based on lab results) software models for CYME and ASPEN software tools that fully capture the SI operation
4. **Field installation** – Based on the prior step implement SI communications and control via proposed head end software to at least one DG project[3] connected or planning to interconnect to the Clifton Park Elnora or Grooms road feeders.
5. **Field testing** – Develop and conduct testing cycles and Measurement and Verification (M&V) to answer the following questions at a minimum:
    a. What is the SI impact with and without Smart Grid VVO/CVR (i.e. VVO/CVR system offline)?
    b. What is the DG impact on Smart Grid VVO/CVR without SI control?
    c. Do secondary Volt/VAR devices overlap or integrate with SI?
    d. Can the benefits identified in task 1 be verified?
    e. What is the value to DG developers/owners?

[2] Consider how SI can support the company's EAM goals i.e. peak load reduction, energy efficiency and DG interconnections

[3] Front of the Meter (FTM) or Behind the Meter (BTM) DG projects in the ~1-5 MW range are most valuable to understand their impact. DG BTM would also be helpful to better understand the building-to-grid relationship.

f. What are the pros and cons to different hierarchical control philosophies?
g. Can the system be hacked from a cyber perspective?

Teaming

Proposers are encouraged to partner to create the comprehensive skill set and experience needed to successfully complete the project. This challenge is expected to require expertise in the following areas:

- Inverter controls and manufacturing
- Information technology and cyber security
- DER development
- R&D laboratory
- VVO/CVR controls
- Utility communication systems
- Utility field experience

Teams should submit a single proposal with one partner identified as the proposal lead.

Opportunities for collaboration with other NY utilities may be considered depending on the proposals received and as the project evolves.

Project Timeline (completion dates)

Milestone	Techno-economic study	Business case	National Grid Lab Test	Field Demonstration	Final Report
Date	Q4 2019	Q1 2020	Q3 2020	Q3 2021	Q4 2021

Additional Considerations

Proposers shall be responsible for any agreements with DER owners used in the project.

National Grid will provide data such as CYME files, one-lines and other non-Critical Energy Infrastructure Information (CEII) information

A Non-Disclosure Agreement (NDA), Memorandum of Understanding (MOU) and a Data Security Agreements (DSA) will likely be required between the proposer and National Grid.

Other related SI projects National Grid is involved in may be incorporated/factored into this project over time.