



**Planning Committee  
Final Proposal Report  
Enhanced Inverters**

October 30, 2014

**Issue Summary**

The increased penetration of renewable resources brings with it many planning and operational challenges. Some of these issues are compounded by retirement of traditional coal plants. Enhanced inverters or inverters equipped with additional functionalities such as fault ride through and dynamic reactive support can be used to address some of these issues. PJM wanted to take a proactive view on this issue and explore the options of using these enhanced inverters and take advantage of some of the additional capabilities they can provide.

**Key Issue Dates**

Problem Statement Approval:

Issue Charge Approval:

Charter Approval: February 27<sup>th</sup>, 2014 - MRC

[Enhanced Inverter Problem Statement/Issue Charge](#)

**STAKEHOLDER PROCESS SUMMARY**

**Stakeholder Meetings** - Six stakeholder meetings on this topic were conducted between March 31<sup>st</sup>, 2014 and August 13, 2014.

**Education** - Two sessions were held on 3/31/2014 and 4/28/2014 dedicated to stakeholder education. Mr. Daniel Brooks, Mr. Aminul Huque and Mr. Jeff Smith from EPRI and Mr. Bill Alvarez and Mr. Brian Riccitelli of SMA America, LLC, reviewed current inverter standards and capabilities.

**Interest Identification, Design Components, Solution Options** – Meetings held on 5/30/2014 and 6/27/2014 focused on interest identification, design components and package development as part of the CBIR lite process. PJM posted its package for stakeholder review on 7/22/2014. PJM reviewed the package at the 8/13/2014 meeting and modified the package based on stakeholder comments. No other packages were proposed.

**Status Reporting** – Regular status reports were provided to the PC, OC as well as the SOS and relay subcommittee. Formal minutes were posted to the [PJM PC website](#).

**Final report** - The group reached a Tier 1 Consensus Package which forms the basis of its report. A non-binding [poll](#) was sent out requesting feedback on support for the PJM Package. A total of 69 responses were received with 68 responses in support of the package and one response opposing the package. A total of 98.55% of the responses were in support of the package.



## 1. Recommended Proposal

The recommendations are applicable only to PJM connected FERC jurisdictional inverter based generators. These generators are defined as asynchronous generation in the PJM footprint that either have an ISA (Interconnection Service Agreement) or a WMPA(Wholesale Market Participation Agreement). They are not applicable to merchant transmission facilities or HVDC inverter-converter facilities or to Attachment BB projects. Also, they are not applicable to existing generation or generation in the new service queue.

The recommended package consisted of six components:

1. Active Power Control: PJM connected FERC jurisdictional inverter based generators must have the capability to have an automated reduction of active power in response to high system frequency with droop characteristics as well as have an automated increase in active power in response to low system frequency with droop characteristics if the resource has additional power available.
2. Reactive Power Control: PJM connected FERC jurisdictional inverter based generators must have the capability to autonomously provide dynamic reactive support within a range of 0.95 leading to 0.95 lagging at inverter terminals. A wider range may be required if the system impact study or a TO study indicates that the 0.95 leading to 0.95 lagging will be insufficient.
3. Voltage ride through: PJM connected FERC jurisdictional inverter based generators must adhere to NERC PRC-024 standard irrespective of generator size.
4. Frequency ride through: PJM connected FERC jurisdictional inverter based generators must adhere to NERC PRC-024 standard irrespective of generator size.
5. Ramp rate limitations: PJM connected FERC jurisdictional inverter based generators must have the capability to limit ramp rates.
6. Implementation time frame: Effective date will apply only to new queue requests; no retroactive requirements.

## 2. Standing Committee Results

The proposal was endorsed by the Planning Committee on 10/9/2014 by acclamation.

### Appendix I: Supplemental Documents

1. [Enhanced Inverter Problem Statement and Issue Charge](#)
2. [Options and Solution Matrix](#)
3. [Planning Committee Presentation](#)



## Appendix II: Stakeholder Participation

Last Name	First Name	Company Name	Sector
Ahmed	Hamad	PJM Interconnection	Not Applicable
Alvarez	Bill	SMA America	Not Applicable
Baker	Scott	PJM Interconnection	Not Applicable
Berner	Aaron	PJM Interconnection, LLC	Not Applicable
Black	Jon	ISO New England	Not Applicable
Brodbeck	John	Potomac Electric Power Company	Electric Distributor
Brooks	Daniel	EPRI	Not Applicable
Burlew	Sarah	PJM Interconnection, LLC	Not Applicable
Calore	James	Public Service Electric & Gas Company	Transmission Owner
Campbell	Bruce	EnergyConnect, Inc.	Other Supplier
Carmean	Gregory	OPSI	Not Applicable
Chu	Ron	Exelon Generation Co., LLC	Generation Owner
Connelly	Nancy	Duke Energy	Transmission Owner
Dinkel	Alex	Atlantic City Electric Company	Electric Distributor
Domian	Christin	Mitsubishi Electric Power Products Inc.	Not Applicable
Engelmann	Alan	Commonwealth Edison Company	Transmission Owner
Fabiano	Janell	PJM Interconnection, LLC	Not Applicable
Fecho	Thomas	AEP Energy Partners, Inc.	Other Supplier
Filomena	Guy	Customized Energy Solutions, Ltd.*	Not Applicable
Greening	Michele	PPL EnergyPlus, L.L.C.	Transmission Owner
Grimes	Mike	EDP Renewables North America, LLC	Generation Owner
Hall	Donald	Potomac Electric Power Company	Electric Distributor
Hamilton	Brian	North American Electric Reliability Corporation	Not Applicable
Hendrzak	Chantal	PJM Interconnection, LLC	Not Applicable
Huque	Aminul	EPRI	Not Applicable
Jacobs	Mike	Union of Concerned Scientists	Not Applicable
Kay	Thomas	Commonwealth Edison Company	Transmission Owner
Keshavamurthy	Bhavana	PJM Interconnection, LLC	Not Applicable
Key	Thomas	EPRI	Not Applicable
Khadr	Esam	Public Service Electric & Gas Company	Transmission Owner
Kliros	Chris	Commonwealth Edison Company	Transmission Owner
Kouam Kamwa	William	American Electric Power	Transmission Owner
Koza	Frank	PJM Interconnection, LLC	Not Applicable



Lacy	Catharine	Dominion Virginia Power	Not Applicable
Laios	Beverly	American Electric Power	Transmission Owner
Laios	Takis	American Electric Power	Transmission Owner
Ma	Alex	Invenergy, LLC	Generation Owner
Mabry	David	McNees Wallace & Nurick LLC	Not Applicable
Marchewka	Grant	FirstEnergy Corporation	Transmission Owner
Miehke	Tracy	PJM Interconnection, LLC	Not Applicable
Murray	Charlie	Invenergy LLC	Generation Owner
Musser	Claire	Tangent Energy Solutions, Inc.	Other Supplier
Rever	Katie	Solar Energy Industries Association	Not Applicable
Ricitelli	Brian	SMA America	Not Applicable
Sanders	Melanie	Exelon Business Services Company, LLC	Transmission Owner
Schooley	David	Commonwealth Edison Company	Transmission Owner
Schuyler	Ken	PJM Interconnection, LLC	Not Applicable
Scoglietti	Barbara	Tangent Energy Solutions, Inc.	Other Supplier
Shakibafar	Mehdi	Virginia Electric & Power Company	Transmission Owner
Slade Jr.	Louis	Virginia Electric & Power Company	Transmission Owner
Smith	Jeff	EPRI	Not Applicable
Smith	Mark	AEP Energy Partners, Inc. (AEP Retail)	None
Steinkuhl	Steve	Duke Energy Business Services LLC	Transmission Owner
Taylor	Lindsay	Tangent Energy Solutions, Inc.	Other Supplier
Webster	John	IceTec.com, Inc.	Other Supplier