February 8th, 2019

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Subject: Letter of Support for AEMO's DER Disturbances Report (February 2019)

To Whom It May Concern:

The Electric Power Research Institute, Inc. ("EPRI") is pleased to provide this letter of support for AEMO's written report entitled "DER behavior during power system disturbances", based on a recent review of the report's technical accuracy and the alignment of its recommendations with international leading practices.

EPRI is a nonprofit corporation organized under the laws of the District of Columbia Nonprofit Corporation Act and recognized as a tax exempt organization under Section 501(c)(3) of the U.S. Internal Revenue Code of 1986, as amended, and seeks involvement in furtherance of its public benefit mission. EPRI undertakes public benefit research on topics surrounding the production and distribution of electric power and the impact of these activities on the environment. The Electric Power Research Institute is devoted to providing research and development, thought leadership, and global collaboration relating to the generation, delivery, and use of electricity for the benefit of the public. EPRI members represent 90% of the electricity generation in North America with additional international participation in 35 countries.

EPRI's staff in the Power Delivery and Utilization Sector has conducted technical solar integration and grid operations and planning research for over 22 years. It has maintained a fully-staffed power electronics lab throughout this time and regularly uses a wide range of software tools to analyze aggregate DER impacts on distribution and transmission grids. The lab is responsible for evaluating 100's of solar integration test set-ups, configurations and specifications through simulation studies, laboratory testing, field deployment and demonstration projects. The ongoing work within these areas provides EPRI members and the public with information related to DER modeling, performance, applications and integration with grid planning and operations. This information supports the continued advancement of electric power distribution systems, and provides a technical foundation for consultation with electric power sector stakeholders.

Recently, EPRI staff (see appendix) had the occasion to engage with AEMO's DER Program team to evaluate their approach to integrating distribution-connected solar and

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other distributed energy resources in alignment with IEEE Std 1547-2018™ ("1547"), a standard published by the Institute of Electrical and Electronics Engineers (IEEE). EPRI's staff has unique experience with the drafting of technical interconnection and interoperability (communications) requirements, such as in IEEE Std 1547-2018, through thought leadership during the past five years. Over the past year, EPRI also obtained valuable knowledge from supporting distribution utilities in implementing the new 1547 standard in coordination with transmission and distribution planners.

AEMO's report proposes DER ride-through and grid support performance capabilities based on the assumptions of future high DER penetration and utilization aiming at maintaining high reliability of the bulk system. This is consistent with the EPRI concept of an Integrated Grid (integratedgrid.epri.com) where overall reliability and resiliency are managed considering the characteristics of resources at all levels with a goal of increasing benefits to the public.

Additionally, AEMO's Report envisions that DER ride-through operation may pose challenges to existing distribution planning, protection, and safety practices. The stakeholder consultation proposed by AEMO could be one way to allow utilities to interactively leverage collaborative learning that could in turn advance AEMO and distribution network service providers (DNSPs). This can lead AEMO and DNSPs to mutually recognize, manage and assist each operational area's responsibilities to more adequately balance the distribution and transmission needs on each side. Subject to thorough consultation with DNSPs prior to enforcement of the proposed requirements, EPRI is directionally supportive of DER ride-through and grid support requirements during disturbances.

The team at AEMO has shown a demonstrated commitment to incorporate feedback from EPRI to make design improvements to the proposed approach outlined in the report. EPRI would look forward to continued engagement to advance the approach and method embodied by the AEMO Report consistent with EPRI's independent, objective and scientifically unbiased research work related to the following challenges and opportunities (see the list of references in the appendix):

- Coincidental disconnection or reduction of power output of large amounts of DERs in an interconnection during voltage and frequency disturbances is becoming increasingly impactful on grid operations as DER levels increase. [1-2]
- Modern distributed PV and other DER, including smart inverters, are typically capable of advanced functional performance and interoperability (communication) that may provide benefit to the grid. For example, they can remain connected (ride-through), adjust their output (watts or vars), and respond to remote commands to address certain grid conditions. [3-6]
- Test and verification methods are becoming increasingly important internationally to verify performance and interoperability of modern DER, including smart inverters, prior to, and after deployment. [7]

- Input and guidance from all stakeholders, including collaborative learning, is critical to successful outcomes with respect to implementation of these new technologies. [4, 8]
- Collection of information on DER and load behaviour during disturbances and adequate representation of aggregate DER performance is challenging and an evolving area of investigation. [9-10]

EPRI is directionally supportive of the approach outlined in the AEMO Report with the understanding that EPRI does not endorse specific facilities, companies or products, programs or projects or allow any of its work to be used for lobbying, campaigning or political activities. Additionally, the target dates proposed by AEMO would need to align with the anticipated dates by which certified DER equipment may become available on the relevant market(s). This qualification relates to the need to match performance capabilities proposed by AEMO with respective products, certifications, and the relevant requirements specified in IEEE 1547 because it may not be possible for the approach and method proposed by the AEMO Report to be certified until the 2021-2022 timeframe.

This letter does not offer cost share, financial or other support. For the avoidance of doubt, this letter does not, and may not be, construed by EPRI, AEMO or any other third party as creating any legally binding obligation or as creating any requirements.

EPRI has a long history of participating in many collaboration activities with the utility and electric power system sectors, as well as governmental entities. The mission of the proposed approach and method appears to be consistent with EPRI's and its electric utility members' interests, and EPRI's overall goal of advancing knowledge in this area for public benefit and society at large.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

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Appendices:

- List of references
- Short bios of EPRI staff that reviewed the report

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List of References

[1] Evaluation of Potential Bulk System Reliability Impacts of Distributed Resources. EPRI, Palo Alto, CA: 2011. 1021977

[2] Impact of Variable Generation on Voltage and Frequency Performance of the Bulk System. Case Studies and Lessons Learned. EPRI, Palo Alto, CA: 2014. 3002003685.

[3] Analysis of Voltage and Frequency Performance of the Bulk System with High Levels of Variable Generation and Distributed Energy Resources. Case Studies and Lessons Learned. EPRI, Palo Alto, CA: 2016. 3002007496. A synopsis of this research is publicly available at http://integratedgrid.com/wp-content/uploads/2016/07/van-Ruitenbeek-Boemer-et-al.-2014-A-Proposal-for-New-Requirements.pdf

[4] Recommended Settings for Voltage and Frequency Ride-Through of Distributed Energy Resources. Minimum and Advanced Requirements and Settings for the Performance of Distributed Energy Resources During and After System Disturbances to Support Bulk Power System Reliability and Their Respective Technical Implications on Industry Stakeholders. EPRI, Palo Alto, CA: 2015. 3002006203. [Online] Publicly available at https://www.epri.com/#/pages/product/000000003002006203/

[5] Impact of DER Voltage Regulation and Voltage Ride-Through Settings on Fault-Induced Delayed Voltage Recovery. EPRI, Palo Alto, CA: 2017. 3002011112.

[6] IEEE Standard 1547™ – Communications and Interoperability. New Requirements Mandate Open Communications Interface and Interoperability for Distributed Energy Resources. EPRI, Palo Alto, CA: 2017. 3002011591. [Online] Publicly available at https://www.epri.com/#/pages/product/000000003002011591/.

[7] Assessment of Interoperability Achieved through IEEE Std 1547-2018 and IEEE P1547.1. Results from EPRI Interoperability Testing and Market Research. EPRI, Palo Alto, CA: 2018. 3002013473.

[8] Navigating DER Interconnection Standards and Practices. Supplemental Project Notification. EPRI, Palo Alto, CA: 2017. 3002012048.

[9] The New Aggregated Distributed Energy Resources (*der_a*) Model for Transmission Planning Studies: White Paper. EPRI, Palo Alto, CA: 2018. 3002013498. [Online] Publicly available: https://www.epri.com/#/pages/product/000000003002013498/

[10] DER Modeling Guidelines for Transmission Planning Studies: 2018 Summary. EPRI, Palo Alto, CA: 2018. 3002013503.

Dr. Jens C. Boemer
Principal Technical Leader
Transmission Operations and Planning
Power Delivery and Utilization

Dr. Jens C. Boemer is Principal Technical Leader in the Transmission Operations and Planning group of the Power Delivery and Utilization Sector at the Electric Power Research Institute (EPRI).

He leads EPRI's strategic research on integrated transmission & distribution planning and operations, including projects on the grid integration of renewable and distributed energy resources with a focus on power system stability issues. His areas of expertise include interconnection guidelines, aggregated modeling of distributed solar photovoltaics for bulk power system reliability studies, and DER communications and control. Boemer has gained industry reputation for leading the timely revisions of IEEE Standards 1547 and 1547.1.

Boemer is uniquely skilled to balance power system aspects from a technical viewpoint with stakeholder interests to create practical solutions for the overall benefit of society. This enables him to support technical and regulatory decision making with solid technical foundation.

Jens Boemer joined EPRI in November 2014 with 10 years of experience in technical and regulatory requirements that helped to facilitate the German "Energiewende" (energy transition). In 2013/2014 he studied at Delft University of Technology, The Netherlands, in the Intelligent Electrical Power Grids group of the Electrical Sustainable Energy department from where he obtained a Ph.D. degree in 2016. Until October 2012 Boemer was Senior Consultant in the Power Systems and Markets Group at the Ecofys premises in Berlin, Germany. He received his Dipl.-Ing. in Electrical Engineering from Technical University of Dortmund, Germany, in 2005 where he specialized on power systems and renewable energies.

Boemer is member of IEEE, CIGRÉ, and VDE.

Dr. Ben York
Technical Leader
Integration of Distributed Energy Resources
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Ben York, Ph.D., is a Technical Leader who leads several strategic projects related to distributed energy resources and EPRI's Integrated Grid concept. He also guides ongoing research and technical discussion on inverter behavior, power quality, and distribution system grounding. Ben has provided key technical guidance on inverter behavior to industry-leading organizations, such as Hawaiian Electric, Solar City (now Tesla), and the Joint Utilities of New York. Ben also co-authored the IEEE/ANSI C62.92.6 standard on system grounding for inverters.

Eamonn Lannoye, Ph.D.
Technical Leader,
Grid Operations and Planning
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Eamonn Lannoye, Ph.D., is Technical Leader in the Grid Operations and Planning research area of EPRI International. In this role, he conducts and leads research relating to generation planning, resource adequacy, outage coordination, generation scheduling and ancillary services in the context of increasing integration of renewable generation. He serves as a technical liaison between European members and EPRI's Grid Operations and Planning research project.

Eamonn conducts studies related to the quantification and assessment of system flexibility needs and the identification of solutions. He has developed software tools to support system planners plan to meet variability and uncertainty needs. He has also conducted production cost, capacity adequacy and capacity value studies and operational solar forecast trials.

Eamonn received a Bachelor of Engineering (Mechanical) and a PhD in Power System Planning from University College Dublin in 2009 and 2013 respectively. He is a member of the IEEE, CIGRÉ and Engineers Ireland.

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Aidan Tuohy, Ph.D.
Principal Project Manager
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Aidan Tuohy, Ph.D., is a Principal Project Manager at the Electric Power Research Institute (EPRI).

He joined EPRI in October 2010 and works in the Grid Operations and Planning group. He is the program manager for the EPRI research program on bulk system integration of variable generation. He has worked in flexibility assessment, the impact of variable generation on power system scheduling, integration of renewable generation forecasting, the value of new flexible resources such as demand response and energy storage, and other variable generation integration issues.

Prior to joining EPRI, Dr. Tuohy worked as a consultant to the Irish electricity industry on projects related to wind integration into markets, system operations and planning. He also worked with the International Energy Agency on the Grid Integration of Variable Renewables project.

Dr. Tuohy received a Bachelor of Engineering degree in electrical/electronic engineering from University College Cork, Ireland in 2005. He completed his doctoral degree at the University College Dublin Electricity Research Centre in 2009, on the topic of operating and planning issues in carbon-constrained power systems. During his studies, he spent time in both Risoe-DTU (Denmark) and the National Renewable Energy Laboratory.

Dr. Tuohy has published several journal papers and frequently presents at industry conferences. He chairs the IEEE Power and Energy Society Task Force on Power System Operations with Variable Generation and the Energy Systems Integration Group (ESIG) working group on Operating Impacts and Market Design, and is also involved in IEA, IEC and CIGRÉ.

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