

# Salt River Project (SRP) Integrated System Plan Technical Working Session: Inverter-Based Resources

*Prepared by Kearns & West*

## Technical Working Session – Meeting Overview

As part of the Integrated System Plan (ISP), Salt River Project (SRP) is hosting Technical Working Sessions where experts from around the country and SRP explore special topics. This session focused on inverter-based resources (IBRs). The purpose was to gather expert opinions, hear stakeholder questions and discuss these resources to better understand implications for the ISP and future planning processes.

### Meeting Objectives

- Understand the power system impacts of integrating high levels of IBRs and any uncertainties
- Highlight solutions for mitigating challenges and uncertainties
- Identify improvements to long-term planning, operational readiness and modeling processes to better account for increasing levels of IBRs in future planning processes

**Topic:** Inverter-Based Resources Integration

**Date:** February 24, 2023

**Time:** 1:00-3:30 p.m. MST

**Location:** Virtual

All ISP stakeholders from the Large Stakeholder Group and Advisory Group were invited, totaling more than 140 organizations. Approximately 50 stakeholders from 37 organizations attended the Technical Working Session with additional SRP staff members and consultants joining the webinar. Please see the appendix for attendance information. The [meeting agenda](#) and [presentation](#) are available at the [ISP portal](#).

### Welcome and Agenda Overview

Bobby Olsen, Senior Director of Corporate Planning, Environmental Services and Innovation at SRP, welcomed attendees to the webinar and reviewed the meeting objectives ([slide 5](#)) and agenda ([slide 6](#)). He highlighted the opportunity for SRP to hear from external experts and learn about opportunities and challenges with IBRs.

### SRP System: Inverter-Based Resource Penetrations & Readiness

Angie Bond-Simpson, Director of Integrated System Planning and Support at SRP, introduced the session by highlighting the need for a holistic view of the power system where planning and operations go hand in hand. She emphasized that one purpose of the Technical Working Session on IBRs is for SRP to expand understanding of how to integrate its current resources

and ensure customer satisfaction without sacrificing its mission. She shared that the composition of the panel and inclusion of the Large Stakeholder Group in addition to the Advisory Group was intended to ensure multiple perspectives.

Bond-Simpson then overviewed types of IBRs and explained how the transition to these resources can lead to decarbonization and improved air quality, noting as well declining cost trajectories ([slide 10](#)). She commented on the importance of understanding how to integrate IBRs on the system and indicated how in SRP's existing, planned and modeled resource outlooks there is a major effort to retire coal energy sources. Decreases in coal resources will be offset by an increase in solar, battery and wind resources ([slide 11](#)). She added that this shift in resource mix is a priority for SRP in preparation for the future.

Bond-Simpson next described some IBR planning and operational challenges. She commented on the variability and uncertainty of weather-dependent resources, the lack of spinning mass for inertia and how renewables operating today were not designed for voltage and frequency control, and additional operating limitations of IBRs ([slide 12](#)). She concluded her remarks by stating that SRP recognizes the need to be intentional with its operations planning.

Scott Anderson, Director of Operational Readiness at SRP, described efforts around IBR integration undertaken since 2021. He began by sharing the fundamental responsibilities of SRP – maintaining reliability, safety and cost effectiveness – as a balancing authority and noted how IBRs play a critical role and bring with them significant opportunity. He defined Operational Readiness as the capability for SRP to operate the future grid safely, reliably and cost-effectively as renewable energy resources are added. He described how a diverse SRP team launched its Operational Readiness program and completed a comprehensive analysis for developing a strategy for operating this future grid. Anderson then described five themes of operational readiness related to IBRs ([slide 13](#)).

## Panelist Presentations

Anderson introduced Tess Williams, Principal at Sound Grid Partners, as the moderator for the panel presentations and discussion. Williams introduced the panelists and the range of perspectives represented on IBRs: research/modeling, reliability, market operations, renewable dispatch, and the experience of a utility on the leading edge of IBR integration, renewables forecasting and large-scale transmission.

In their presentations, panelists touched on some common themes around IBRs. They described both the opportunities and risks in the transition to a power system with greater integration of IBRs and the question of how to maintain reliability in this transition. Panelists spoke to the complexity and uncertainty of forecasting these complex and variable resources and shared information on current research and development of storage and other technologies that address these concerns. Other themes included considerations for extreme weather and

climate change, the need for new and uniform standards for operation of IBRs, and how new market operations designs are needed to integrate IBRs with existing resources and the power grid.

### Future Opportunity and Challenges with High Levels of Inverter-Based Resources

Nick Miller, Principal at HickoryLedge LLC, spoke from the research and modeling perspective. He described the “complicated space” of IBRs and energy policy and outlined the stages of the energy transition in the effort to decarbonize. In discussing key characteristics and challenges in the different phases of system integration, he pointed to how generation from IBRs varies based on time-scale (e.g., seconds to days to years) and penetration, or share of IBRs in the system. He noted that while most variable weather dependent resources (e.g., wind and solar), depend on inverters to deliver power to the grid, the detailed characteristics of the inverters are only important in the fast time frames up to a few seconds. Noting that today IBRs have the potential be much more stable as compared to previous technology, he presented National Renewable Energy Laboratory (NREL) data on wind and solar resources and showed examples of systems running with high percentages of IBRs, including some small island grids reaching 100%. He said the current question in the industry is how to reach maximum instantaneous power with IBRs. Miller wrapped up his remarks by saying that the current generation of wind and solar inverters will not be able to reach 100% without accompanying synchronous grid support. Grid-forming inverters are commercially available from several battery energy storage suppliers, and guidance on specifications for grid-forming inverters has been published by the Unifi consortium. However, US industry is years away from establishing standards for grid-forming IBRs.

### Reliability Perspectives: Rapid Integration of Increasing Levels of Inverter-Based Resources

Ryan Quint, Director of Engineering and Security Integration at the North American Electric Reliability Corporation (NERC), introduced NERC as a not-for-profit international regulatory authority that develops and enforces reliability standards for the power grid. He described Electric Reliability Organization (ERO) priorities around resource availability, extreme weather and IBRs and how to ensure a reliable and resilient bulk power system under rapid grid transformation. After explaining the ERO risk management framework, Quint shared NERC’s IBR strategy for maintaining reliability. He then described disturbances where a significant number of solar and other IBRs trip offline unexpectedly for normal grid faults. He went into the details of the 2022 Odessa, Texas disturbance, noting that NERC is uncovering new issues with every event and learning from them. Quint concluded by showing a list of IBR standards under development and IBR risks, such as poor modeling, which he emphasized should be taken seriously.

### Inverter-Based Resources: Market Operations Perspective

Guillermo Alderete Batista, Director of Market Analysis and Forecasting with the California Independent System Operator (CAISO), began by introducing CAISO as a non-profit public benefit corporation that manages the wholesale energy market in California and is a member of the Western Electricity Coordinating Council (WECC). He described how aggressive renewable goals in multiple markets are setting the pace for resource adoption and then explained how integration of IBRs introduces uncertainty in forecasting due to their variability. In discussing storage, he noted that its explosive growth is changing the market and regulation landscape, which will require both advanced forecasting techniques and a design to support market participation. Alderete ended by describing how market operations need to consider the complexities of IBRs and make advancements in handling uncertainties.

### Lessons Learned on Inverter-Based Resource Dispatch

Mahesh Morjaria, Executive Vice President for Plant Operational Technology at Terabase Energy, addressed the renewable dispatch perspective by outlining lessons learned about utility-scale photovoltaic solar, solar hybrid plants and the role of plant controls. He described the grid-friendly features required by NERC for an IBR plant, highlighting how it could be used for frequency control and ramping capability with greater flexibility. He then discussed a study conducted with E3 that simulated flexible solar operations where they were able to reduce curtailment by 60% annually. He then outlined the attributes of a grid-friendly IBR plant that make it more flexible and responsive than current fossil fuel resources. In describing storage, he commented that solar combined with storage can provide firm capacity as plant controls can be managed by the operator with scheduled charging and discharging. Morjaria concluded by emphasizing how adding storage enhances the grid capability of these IBR plants and illustrating how complex dispatch is handled over a typical day.

### Utility Perspective

Keith Parks, Senior Data Scientist with Xcel Energy, offered perspectives from a utility with a service territory encompassing eight states and with a significant number of IBRs integrated on its system. He began by describing Xcel's system and some of its features, noting the dominance of wind resources in its portfolio. He continued by describing significant battery resources coming online in 2023 and the construction of a major transmission project. On providing year-round resource adequacy to serve the net load, he first addressed climate change and explained how more hot days are occurring earlier than the traditional summer months and extending later in the year than in the past. He then described the reliability implications for winter when large amounts of solar are added in 2030. The number of peak net load days in winter increases, and because there may be days with poor wind, other resources such as storage are needed. He also addressed maintenance considerations, showing how the spring and fall maintenance windows shrink with additional solar resources on the system and

the longer hot-temperature periods during the summer. Parks concluded by saying that solar provides great coverage for planned outages for maintenance in the summer months but inadequate coverage in the winter and shoulder seasons.

## Q&A

Participants in the facilitated discussion included external panelists Nick Miller, Ryan Quint, Guillermo Alderete Batista, Mahesh Morjaria and Keith Parks. Tess Williams from Sound Grid Partners served as the moderator. Topics discussed included performance of inverters, how panelists’ organizations have responded to feedback from NERC, the role of distributed solar resources and the transition to automatic generation control.

On inverter performance and the learning curve for more advanced capabilities, comments centered on the need for resources to stay connected to the grid and provide service during normal and abnormal events. An important element are the controls programmed into devices and the resulting problems when these controls are programmed incorrectly. It was noted that many of these questions about inverter performance are foundational problems, not enhancements, and require studies of the actual equipment to be used in the field. Another need is for designers and developers to communicate with one another from the beginning to meet defined services and functionalities. When that coordination does not occur, problems emerge during the commissioning of projects.

When asked about the actions their organizations have taken in incorporating NERC’s feedback, multiple panelists commented on the need to define uniform standards for operation of IBRs. They described reporting resource events to NERC and working with manufacturers to address standards and requirements, noting the lack of uniformity in standards as a challenge. Whereas some organizations are able to draw on their relationships with resource providers to leverage capabilities, such as voltage regulation and control as a means for stabilizing the grid, others commented on missed opportunities, expressing that the technologies have capabilities, but the execution is poor.

Panelists then discussed how correct frequency measurements and programming of inverters are needed for proper function, which goes back to defining the operational requirements. It was noted this is a human challenge, not one dependent on physics, and involves balancing the opportunities and potential challenges. Also important is the continued analysis of events so NERC can understand them and write new standards. One challenge is communicating with power entities about the capabilities of IBRs – such as for voltage control – due to the rapid pace of new interconnections where Federal Energy Regulatory Commission (FERC) guidance may not be available. IBRs have capabilities that are not currently being explored and there is a need to determine ways to transfer general knowledge about these opportunities. Standards need to be created and disseminated.

Discussion then shifted to distributed solar resources and their role in helping with load management and reliability. One challenge for operators is the lack of visibility, especially for resources that are behind the meter. Although customer-sited resources such as rooftop solar impact the system and demand, operators lack the ability to monitor them, which then affects forecasting and operations. Without observability and controllability of distributed resources, it's difficult to then make sense of economic and reliability data. A further challenge is the large number of small resources and costs for the communication needed to aggregate them at scale.

Panelists discussed that while providing services back to the grid may not be cost-effective, demand management is a valuable function of distributed resources. Pilot programs with dispatch of electric vehicles have shown promise for load-shifting; however, current programs are limited to once-a-day forecasting. Another consideration are differences in distributed generation according to geography and type. One example provided was of Tesla controlling 30% of distributed generation in one market – a move driven by financial priorities rather than by reliability concerns.

On the topic of automatic generation control, where utilities can monitor load and dispatch resources for reliability services, panelists responded to questions about the process for bringing renewable resources under that type of control and future possibilities. A panelist provided an example for wind resources that from 2006 or 2008 onward were able to be dispatched with precision and how this capacity was required beginning around 2011 with solar requirements following after. One consideration is the economic sense it makes to dispatch these resources and how to build generation versus control capabilities into power purchase agreements. Another issue is whether the infrastructure or framework is in place to help with the right incentives and the need to adjust the market design to align these incentives. Over 90% of the curtailment issued for solar and wind is due to congestion. Regulating service is a limited market, and storage resources have saturated the regulation market. There is now more supply of IBRs and more demand for regulation.

When asked about coping with uncertainty, panelists described a changing world with regard to forecasting that must consider a greater number of factors, including customer-sited resources behind the meter. One solution is blending forecasts from different providers and with different time-scales to make sure there is flexible capacity – already online or quickly available – to mitigate changes in load. Aggregation across a greater area, adding storage and using plant controls can also help with responsiveness.

In closing, Bond-Simpson noted the number of changes panelists had discussed. She asked them to share something in the power system that does not change and how to leverage previous expertise. Responses included the physics of the transmission system; the goals of providing reliable, cost-effective service in a low-carbon environment; and the need for continued innovation and always having new problems to solve. Panelists also shared

perspectives on the shift from a largely analog to digital power grid and how a larger, future power system will deliver energy differently to customers.

Bond-Simpson then shared how the ISP project team will be using the information from the webinar to inform conversations about the 42 different system plans under analysis as part of the ISP study plan. She noted this will be important as the team discusses how to prepare for the high penetration of IBRs in SRP's system. She explained that upcoming meetings with the Advisory Group would discuss this topic and explore some preliminary results of the ISP analysis. Planning for future Technical Working Sessions on regional markets (March) and time-of-use (April) is underway.

Bond-Simpson concluded the webinar by expressing appreciation for the panelists' passion for the topic of IBRs and thanking the participants and facilitator for their involvement.



## Appendix

### Meeting Attendance

Large Stakeholder Group and Advisory Group Organizations (groups represented on 2/24/2023 are shown in **bold**)

#### **AARP**

Advanced Energy Economy  
AEPCO

#### **AES Clean Energy**

Air Products  
American Lung Association

#### **AMPUA**

AMWUA  
Apache County

#### **Apache County Economic Development**

Apex Clean Energy  
Apple Inc.

#### **AriSEIA**

Arizona Cattle Growers Association  
Arizona Center for Law in the Public  
Interest

Arizona Chamber of Commerce  
Arizona Commerce Authority  
Arizona Competitive Power Alliance  
Arizona Cotton Growers Association  
Arizona Energy Policy Group

Arizona Farm Bureau  
Arizona Hispanic Chamber of  
Commerce

Arizona Lodging and Tourism  
Association

Arizona Power Authority

#### **Arizona Public Service**

Arizona Residential Utility Customer  
Office  
Arizona Solar Deployment Alliance

Arizona Solar Energy Industries  
Association/Veregy

Arizona State Land Department

#### **Arizona State University**

Avangrid Renewables

Atlas Renewable Power

AzCPA

AZ Thrives

AZ PIRG

AZ Strategies

AZ Sustainability Alliance

#### **Balanced Rock Power**

Basha's

Beatitudes Campus

Boeing

Building Owners and Managers  
Association (BOMA)

#### **Bureau of Land Management**

Calpine

Candela Renewables

Casa Grande

Chicanos Por La Causa

Christian Care Inc., Mesa District

City of Apache Junction

City of Chandler

City of Mesa

#### **City of Phoenix**

City of Tempe

#### **CMC Steel, AZ**

CommonSpirit Health

ConnectGen, LLC

Coolidge

Copper State Consulting Group

Cushman & Wakefield

Cyrus One

Digital Realty

DMB

East Valley Chamber of Commerce

East Valley Partnership

#### **Enel Green Power North America, Inc.**

Energy Exemplar, LLC

Environmental Defense Fund

**EPRI**

Facebook  
Forest Service U.S. Department of  
Agriculture  
Fort McDowell Yavapai Nation  
Freeport-McMoRan Copper and Gold  
Gamage & Burnham Attorneys at Law

**General Electric**

Gila Bend  
Gilbert  
Glendale  
Google  
Greater Phoenix Economic Council  
Greater Phoenix Leadership  
Greenlots  
Home Builders Association of Central  
Arizona  
Hospice of the Valley  
Innergex  
Intel

**Interwest Energy Alliance****Invenergy**

JKL Consulting Services, LLC  
Kroger Co. (Ralphs and Food4Less)  
Kyl Center for Water Policy  
Local First Arizona  
Mercy Gilbert Medical Center/Dignity  
Health  
Mesa Community Action Network  
Mesa Gateway Airport  
Mesa Public Schools  
Microchip Technology  
Mitsubishi Hitachi Power Systems  
Americas, Inc.  
Navajo County  
New Leaf/Mesa-CAN  
New Life Christian Center, Coolidge

**NextEra Energy Resources**

Northern Arizona University

**NREL**

Onward Energy

**Origis Energy****Orsted Onshore North America**

PAC Worldwide  
Page  
Pattern  
Phoenix Chamber of Commerce  
Pinal County  
Profile Precision Extrusions  
Queen Creek Chamber of Commerce  
Queen Creek Unified School District  
Roosevelt Water Conservation District  
Salt River Pima-Maricopa Indian  
Community  
SRP Customer Utility Panel  
Scottsdale  
Seguro Energy  
Sierra Club

**Southwest Energy Efficiency Project**

Southwestern Power Group  
St. Johns  
St. Paul Church, Randolph  
Starwood Energy Group Global, Inc.  
Sustainable Energy Power Alliance  
The Nature Conservancy (Arizona  
Thrives)  
Tierra Strategy  
Tormoen Hickey, LLC  
Town of Florence  
Town of Springerville

**Tucson Electric Power**

United Dairymen of Arizona  
University of Arizona  
Valle Del Sol Strategic Initiatives: The  
Real Arizona Coalition  
Valley Partnership

**Vote Solar**

Walmart  
Wärtsilä North America, Inc.  
West Marc  
Western Grid Group  
**Western Resource Advocates**  
Wildfire

## Other Organizations in Attendance

Arizona Energy Pros  
Bank 34  
BayWa Renewable Energy  
Grays Harbor Energy, LLC  
Lotus Infrastructure Global Operations, LLC  
Mi Familia Vota  
RWE  
SolarEdge Technologies  
Solar Matters Consulting  
Strata Clean Energy  
Sunnova  
Sunny Energy, LLC  
Triple Oak Power

## Key SRP Staff

Angie Bond-Simpson, Director of Integrated System Planning & Support  
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## Board & Council Observers

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