THE STATE OF CALIFORNIA
BEFORE THE
CALIFORNIA ENERGY COMMISSION

In the Matter of,	)	
Preparation of the 2011 Integrated	)	Docket No. RM10-11-000
Integrated Energy Policy Report	)	

COMMENTS OF VIRIDITY ENERGY, INC.

Viridity Energy, Inc. ("Viridity") appreciates the opportunity to comment on the issues discussed at the Committee Workshop held by the California Energy Commission ("Commission") regarding renewable, localized generation. Founded by energy industry executives with decades of experience in power grid, market operations and energy management system technologies, Viridity was launched in 2008 to accelerate the integration of electricity customers' energy resources, including controllable load, energy storage, and distributed energy resources, into the electric grid and the wholesale electricity markets.

INTRODUCTION

In working toward Governor Brown's goal of installing 20,000 MW of renewable energy by 2020 -- including 12,000 MW of localized electricity generation -- the Commission appropriately recognizes both the need to explore reducing costs, and the challenges of integrating large quantities of renewable generation (both centralized and localized) into the grid.

The desirable characteristics of renewable electric generation, especially those generators fueled by wind or by solar energy, are well known. Most importantly, these generators produce electricity at low marginal cost and with little or no emissions of greenhouse gases and other air pollutants. At the same time, these generators are considered intermittent resources or variable energy resources ("VERs"), because their production of electricity increases and declines with variations in sunshine and wind.[1] Successful integration of large quantities of renewable generation depends on overcoming these challenges while preserving the generators' desirable characteristics.

Several facts can help to guide the Commission's efforts:

- Reliable integration of VERs into the grid depends on flexible resources that can make up for the intermittent nature of electric generation powered by the sun and the wind.
- Although fossil-fueled electric generation could provide the necessary complement to renewable VERs, it would increase emissions of greenhouse gases and exacerbate the challenges to California's ability to comply with federal health standards for ground-level ozone.
- Storage and demand resources can both complement renewable VERs, while maximizing the benefits that renewables bring.
- Reforms can encourage the coupling of VERs with storage and demand resources to preserve the environmental benefits of renewable VERs while also preserving reliability.

COMMENTS

1. Reliable integration of VERs into the grid depends on flexible resources that can make up for the intermittent nature of electric generation powered by the sun, the wind, and other renewable VERs.

[1] California Energy Commission, Staff Report, "Developing Renewable Generation on State Property," April 2011, CEC-150-2011-001, p. 5.

The supply of electricity from any electric generator is subject to interruption, on short notice or due to more predictable circumstances:

> On any given day, some generation and transmission capacity is unavailable; some facilities are out for routine maintenance, and others have been forced out by an unanticipated breakdown and require repairs.[2]

Solar and wind-based generators are not immune from such interruptions, especially when clouds temporarily obscure the sun or when the wind dies down. However, interruptions of these resources tend to be different than interruptions of generation from fossil or nuclear resources.

Large-scale fossil or nuclear plants can be temporarily forced out of service suddenly and completely. For example, the tripping of the turbine-generator set can quickly and dramatically cut the output from a nuclear unit; the Nuclear Regulatory Commission considers this an "anticipated operational occurrence," expected to occur at least once during the life of each unit.[3] Fossil-fueled units can also experience sudden forced outages.[4]

In contrast, interruptions of supply from renewable VERs tend to occur more slowly than interruptions from fossil and nuclear generators. One well-known example: on February 26, 2008, a large ramp-down of wind generation in ERCOT coincided with a sudden and unexpected loss of conventional generation and a ramp-up of evening load which occurred more quickly than expected.[5] However, it took 3-1/2 hours for output from the wind generators to drop from 2000

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[2] U.S. – Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations," April 2004 (https://reports.energy.gov/), p. 25.
[3] 10 CFR Part 50, Appendix A.
[4] See, e.g., North American Electric Reliability Council, "Causes of Generating Unit Forced Outages Following Planned Outages," 1992 (http://www.nerc.com/files/Generating-Unit-Availability-Following-Planned-Outages.pdf); Potomac Economics, Inc., "2006 Assessment of the Electricity Markets in New England," June 2007, p. 34 (http://www.iso-ne.com/pubs/spcl_rpts/2006/2006_immu_report.pdf).
[5] Ela & Kirby, "ERCOT Event on February 26, 2008: Lessons Learned," National Renewable Energy Laboratory Technical Report NREL/TP-500-43373, July 2008 (http://www.nrel.gov/docs/fy08osti/43373.pdf), p. 1.

MW to 360 MW.[6] The drop in output from the wind resources was "relatively slow for a power system reliability event," but "typical for large wind events."[7] In other words:

> the aggregate energy output from wind plants spread over a reasonably large area tends to remain relatively constant on a minute-to-minute time frame, with changes in output tending to occur gradually over an hour or more.[8]

Photovoltaic solar facilities can potentially experience substantial ramps during partially cloudy days. These variations can range as high as about 50% over 30 to 90 seconds, and 70% over five to ten minutes.[9] However, photovoltaic solar facilities can achieve economies of scale at relatively small sizes and is often deployed as distributed generation.[10] At smaller sizes, the ramps can be offset without greatly burdening reserves; at larger sizes, the spread of the photovoltaic facility over a larger area may itself reduce the extent of the ramps.[11]

When the supply of electricity from a generator is interrupted, other resources must step in to make up for the missing supply. Accordingly, system operators maintain reserve products to ensure that demand and generation are kept in balance.[12] As the amount of generating capacity from VERs increases, additional operating reserves are needed to maintain balance between generation and load.[13]

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[6] During that time, a 370 MW fossil unit suffered an unexpected forced outage, and load increased by 2500 MW over 45 minutes. Id.

[7] Id. at p. 8.

[8] North American Electric Reliability Corporation, "Accommodating High Levels of Variable Generation," April 2009 http://www.nerc.com/files/IVGTF_Report_041609.pdf), p. 15.

[9] Id. at p. 27.

[10] Id.

[11] Id. at 29.

[12] Federal Energy Regulatory Commission, Notice of Inquiry, "Integration of Variable Energy Resources" ("FERC VER Inquiry"), 130 FERC ¶ 61,053, January 21, 2010, para. 34.

[13] See, e.g., National Renewable Energy Laboratory, "Eastern Wind Integration and Transmission Study," January 2010 (http://www.nrel.gov/wind/systemsintegration/pdfs/2010/ewits_executive_summary.pdf), p. 27.

Generation, storage, and demand resources all can satisfy this need. However, those resources differ in their potential to advance, preserve, or hinder the environmental goals normally associated with renewable VERs.

2. Fossil-fueled resources can provide the additional operating reserves needed, but do so at the cost of undermining VERs' desirable characteristics.

Fossil-fueled combustion turbines can compensate for variations in the output from renewable generators, due to the combustion turbines' ability to ramp up or down quickly when VER generation ramps up or down.[14]

However, when turbines are quickly ramped up and down, their emissions of CO_2 tend to rise. The turbine's heat rate tends to increase at lower levels of output, increasing fuel use and thus CO2 emissions.[15] A turbine's emissions of NO_x, a major contributor to California's high concentrations of ground-level ozone, tend to rise as well. Systems to reduce NO_x emissions may not operate optimally when the turbines' power level is rapidly changed.[16] As a result, one study suggests that estimates of CO_2 emissions reductions from wind-based generation may be overstated by 23 percent if the emissions from combustion turbines are not included; reductions in emissions of NO_x may be overstated by 55 to 80 percent.[17]

[14] Request For Rehearing of Dominion Resources, Inc., et al., FERC Docket ER03-1318, December 12, 2003; Katzenstein & Apt, "Air Emissions Due to Wind and Solar Power," Environ. Sci. Technol. 2009, 253 http://pubs.acs.org/doi/pdf/10.1021/es801437t; Sullivan, Short, & Blair, "Modeling the Benefits of Storage Technologies to Wind Power," National Renewable Energy Laboratory, http://www.nrel.gov/docs/fy08osti/43510.pdf.

[15] Katzenstein & Apt at 253; see also PJM, Operating Agreement, 1.10.1A(e)i.

[16] Id.

[17] Id. at 255.

Other fossil-fueled resources providing reserves will also offset the emissions reductions that renewable VERs can achieve. Oil-fired and coal-fired resources in particular will emit not only CO_2 and NO_x, but will also emit SO_2 and a variety of toxic air pollutants.[18]

Accordingly, California will lose much of the ability of renewable VERs to cut emissions of CO_2, NO_x, and other air pollutants if it relies more heavily on fossil-fueled resources to balance transient increases and decreases in the output from renewable VERs.

3. Storage and demand resources can both complement VERs while preserving the CO_2 and NO_x benefits that VERs can bring.

In Order 719[19], the Federal Energy Regulatory Commission ("FERC") recognized that demand response can provide the reserve and regulation services needed to support the broader integration of renewable VERs.[20] Specifically, the FERC required that demand response resources be eligible to bid to supply energy imbalance, spinning reserves, supplemental reserves, reactive and voltage control, and regulation and frequency response, provided that the resources are technically capable of providing the ancillary service within the response time requirements.[21]

The FERC recently cited the February 2008 wind ramp in ERCOT as a prominent example of the ability of demand response to provide the necessary reserve and regulation services:

For instance, in ERCOT, on February 26, 2008, through a combination of a

[18] U.S. Environmental Protection Agency, "Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units," 65 Fed. Reg. 79825, December 20, 2000.
[19] Wholesale Competition in Regions with Organized Electric Markets, 125 FERC ¶ 61,071 (October 17, 2008) ("Order 719").
[20] Order 719, para. 47 and 49.
[21] Id. at 49.

> sudden drop in power supplied by wind generators, a quicker-than-expected ramping up of demand, and the loss of thermal generation, ERCOT found itself short of reserves. The system operator called on all demand response resources, and 1200 MW of Load acting as Resource (LaaRs) responded within ten minutes, bringing ERCOT back into balance, from 59.85 Hz back to 60 Hz.[22]

In supporting the integration of renewable VERs, the role of demand response is not limited to reducing demand to balance decreases in the output of renewable generators. Demand response can also shift the timing of some energy usage, to absorb generation from renewable VERs (such as wind) that often produce much of their output at night. That is, an end user may be able to shift usage from peak periods to off peak periods. This process offers multiple benefits to the grid: it reduces a peak (through demand response) and fills in a usage valley (both increasing grid load factor and insuring a market for wind generation. Indeed, renewable generation, storage, and demand response used in conjunction with one another provides significant synergies. The improved load factor noted above is indicative of a more efficient grid.

Storage can provide similar support. Like demand response, storage resources can absorb excess generation from renewable VERs at times when overall demand for electricity is low – for example, by charging batteries or flywheels or by pre-cooling buildings. The same storage resources can then be dispatched to discharge energy to balance decreases in the output of renewable generators.[23] Again the result is a more efficient grid with a smaller call for on-peak grid power and greater usage of off peak power, particularly renewable power.

[22] Demand Response Compensation in Organized Wholesale Energy Markets, Docket Nos. RM10-17-000 and EL09-68-000, 130 FERC ¶ 61,213, March 18, 2010, footnote 15.
[23] See, e.g., California Independent System Operator, "Integration of Renewable Resources," November 20007, pp. 93-94.

Demand response and storage offer another important advantage: neither resource directly emits CO_2, NO_x, or other air pollutants, thereby preserving the benefits of renewable VERs in reducing emissions.[24] Furthermore, when the dispatch of demand response or storage avoids the need to ramp a fossil-fueled combustion turbine or other generator, it prevents the resulting increase in emissions. Accordingly, these resources facilitate the integration of renewable VERs into the grid while preserving the emission reductions that renewable VERs can achieve.

4. The coupling of VERs with storage and demand resources should be encouraged, to preserve the environmental benefits of renewable VERs while also preserving reliability.

Outlining its vision for the modern grid, the National Energy Technology Laboratory stated that such a grid will:

> Allow demand response and energy storage to be coupled with intermittent renewable resources to make such resources more viable and contribute a greater percentage of supply.[25]

Effective and efficient coupling of these resources is feasible today. Renewable VERs, energy storage systems, and controllable loads can be managed and optimized together, whether they share the same site or have disparate locations. That management and optimization can incorporate forecasts and real-time information about weather, load, prices, and output of renewable VERs. The result is a firmer, more constant, and more predictable output, as

[24] Viridity recognizes that on those occasions when on-site fossil-fueled generation is deployed to support demand response, at least CO_2 and NO_x emissions will result.

[25] National Energy Technology Laboratory, "Modern Grid Benefits," August 2007 (http://www.netl.doe.gov/smartgrid/referenceshelf/whitepapers/Modern%20Grid%20Benefits_Final_v1_0.pdf), p. 12.

downward ramps of renewable VERs are balanced by load curtailments and/or discharges of stored energy. The reverse is also true, since wind power with maximum output at times of low overall demand can be stored for discharge during times of higher demand, or absorbed by demand shifted to off-peak hours.

5. Microgrids can facilitate the deployment of distributed renewable energy in concert with optimized demand response and storage.

The combination of resources described above promises to be especially constructive when it is accomplished in a microgrid that includes renewable VERs, or in a facility or group of facilities under common control. Those circumstances enhance the opportunity to identify, manage, and optimize all of the relevant resources in a tightly coordinated and timely manner.

To that end, Con Edison has undertaken to explore the benefits of microgrids through a project supported by a federal Smart Grid Investment Grant. In that project, Viridity is working with ConEd, the New York City Economic Development Corporation, and others to optimize advanced building technologies, demand response capability, and solar electric generation from city-owned and privately-owned properties, resulting in clean "virtual" power generation.

With the help of a grant administered by the California Public Utilities Commission, Viridity is working with the University of California, San Diego for a distributed energy optimization project. The grant will support work to significantly improve the economics of solar deployment in California and demonstrate that the barriers to deployment of solar resources can be overcome through optimization scheduling and appropriate tariff incentives. Energy and Environmental Economics, Inc., a San Francisco-based energy consulting firm and leader in cost-benefit analysis and rate design for distributed energy resources, will evaluate the costeffectiveness and alternative management strategies and tariff designs as a sub-contractor to Viridity. San Diego Gas and Electric and the California Independent System Operator will also provide active support to ensure that the project provides meaningful results for utility and grid operators. The project shows how communication and technical barriers can be overcome, while designing rates that fairly balance costs and benefits, promote adoption of solar electric generation, and find customer acceptance. The results of the project will serve as a representative test bed for strategies replicable at sites representing over 15,000 MW of load in California alone.

CONCLUSION

Viridity appreciates the Commission's efforts to identify barriers impeding the reliable and efficient integration of VERs into the electric grid, and the Commission's consideration and attention to these recommendations for minimizing those barriers.

Respectfully submitted,

Viridity Energy, Inc.

By: /s/ ***Laura Manz***

Laura Manz, Senior Vice President
Western Region
Viridity Energy, Inc.
16870 West Bernardo Drive, Suite 400
San Diego, CA 92127
lmanz@viridityenergy.com

By: /s/ ***Allen Freifeld***

Allen Freifeld, Senior Vice President
External Affairs
Viridity Energy, Inc.
100 West Elm Street
Conshohocken, PA 19428
484-534-2191
afreifeld@viridityenergy.com

By: /s/ ***Samuel A. Wolfe***

Samuel A. Wolfe, Managing Director
Legal & Regulatory Affairs
Viridity Energy, Inc.
100 West Elm Street
Conshohocken, PA 19428
609-785-1005
swolfe@viridityenergy.com

By: /s/ ***Drew Adams***

Drew Adams
Business Analyst, Western Region
Viridity Energy, Inc.
16870 West Bernardo Drive, Suite 400
San Diego, CA 92127
920-574-8303
dadams@viridityenergy.com