March 19, 2019

RESPONSE BY OMNES ENERGY TO REQUEST FOR COMMENTS BY NJBPU

1. **How might the implementation of renewable electric energy storage systems benefit ratepayers by providing emergency back-up power for essential services, offsetting peak loads, providing frequency regulation and stabilizing the electric distribution system?**

A. Efficient low-cost energy storage systems benefit NJ ratepayers in several ways.

According to the Sandia Labs report [USDOE Sandia Laboratory SAND2010-0815] prepared by Sandia Laboratories for the U.S. Department of Energy (DOE), energy storage applications can be divided into five categories: electrical supply, ancillary services, grid system applications, end-user/customer applications, and renewable energy integration. Table 1 lists these categories and their associated sub-categories.

Table 1: Energy storage application categories:

Category 1 — Electric Supply
1. Electric Energy Time-shift
2. Electric Supply Capacity
Category 2 — Ancillary Services
3. Load Following
4. Area Regulation
5. Electric Supply Reserve Capacity
6. Voltage Support
Category 3 — Grid System
7. Transmission Support
8. Transmission Congestion Relief
9. Transmission & Distribution (T&D) Upgrade Deferral
10. Substation On-site Power
Category 4 — End User/Utility Customer
11. Time-of-use (TOU) Energy Cost Management
12. Demand Charge Management
13. Electric Service Reliability
14. Electric Service Power Quality
Category 5 — Renewables Integration
15. Renewables Energy Time-shift
16. Renewables Capacity Firming
17. Wind Generation Grid Integration

Table 2: Discharge, size, and economic benefits of energy storage

The table below describes each of the benefits listed in Table 1 in terms of discharge duration (h), capacity (kW or MW), economic benefit ($/kW), potential market size (MW) and total economic value ($). Of these benefits, the largest markets for energy storage are: load following, end-user time-of-use (TOU), and time shifting/capacity firming of renewable energy generation.

		Discharge Duration*		Capacity (Power: kW, MW)		Benefit ($/kW)**		Potential (MW, 10 Years)		Economy ($Million)†	
#	Benefit Type	Low	High	Low	High	Low	High	CA	U.S.	CA	U.S.
1	Electric Energy Time-shift	2	8	1 MW	500 MW	400	700	1,445	18,417	795	10,129
2	Electric Supply Capacity	4	6	1 MW	500 MW	359	710	1,445	18,417	772	9,838
3	Load Following	2	4	1 MW	500 MW	600	1,000	2,889	36,834	2,312	29,467
4	Area Regulation	15 min.	30 min.	1 MW	40 MW	785	2,010	80	1,012	112	1,415
5	Electric Supply Reserve Capacity	1	2	1 MW	500 MW	57	225	636	5,986	90	844
6	Voltage Support	15 min.	1	1 MW	10 MW	400		722	9,209	433	5,525
7	Transmission Support	2 sec.	5 sec.	10 MW	100 MW	192		1,084	13,813	208	2,646
8	Transmission Congestion Relief	3	6	1 MW	100 MW	31	141	2,889	36,834	248	3,168
9.1	T&D Upgrade Deferral 50th percentile††	3	6	250 kW	5 MW	481	687	386	4,986	226	2,912
9.2	T&D Upgrade Deferral 90th percentile††	3	6	250 kW	2 MW	759	1,079	77	997	71	916
10	Substation On-site Power	8	16	1.5 kW	5 kW	1,800	3,000	20	250	47	600
11	Time-of-use Energy Cost Management	4	6	1 kW	1 MW	1,226		5,038	64,228	6,177	78,743
12	Demand Charge Management	5	11	50 kW	10 MW	582		2,519	32,111	1,466	18,695
13	Electric Service Reliability	5 min.	1	0.2 kW	10 MW	359	978	722	9,209	483	6,154
14	Electric Service Power Quality	10 sec.	1 min.	0.2 kW	10 MW	359	978	722	9,209	483	6,154
15	Renewables Energy Time-shift	3	5	1 kW	500 MW	233	389	2,889	36,834	899	11,455
16	Renewables Capacity Firming	2	4	1 kW	500 MW	709	915	2,889	36,834	2,346	29,909
17.1	Wind Generation Grid Integration, Short Duration	10 sec.	15 min.	0.2 kW	500 MW	500	1,000	181	2,302	135	1,727
17.2	Wind Generation Grid Integration, Long Duration	1	6	0.2 kW	500 MW	100	782	1,445	18,417	637	8,122

*Hours unless indicated otherwise. min. = minutes. sec. = seconds.
**Lifecycle, 10 years, 2.5% escalation, 10.0% discount rate.
†Based on potential (MW, 10 years) times average of low and high benefit ($/kW).
†† Benefit for *one year*. However, storage could be used at more than one location at different times for similar benefits.

2. **How might the implementation of renewable electric energy storage systems promote the use of electric vehicles in New Jersey, and what might be the potential impact on renewable energy production in New Jersey?**

A. Energy storage provides definite benefits to electric vehicles especially with respect to transportation fleets. Impact on renewable energy production will depend on volume.

3. What types of energy storage technologies are currently being implemented in New Jersey and elsewhere?

PJM currently states that is has 5,300 MW of energy storage resources, of which 96% is pumped hydropower storage. However, it is not clear for how many hours the 5,300 MW is delivered. (Also see answer to Question 13)

Large Li-ion batteries have been installed in several parts of the world. These batteries use technology developed for the electrical vehicle market where low weight is required. However, the typical duty cycle in EVs is very low and applicability to utility-grade applications may be questionable. Cycle life of Li-ion batteries is only about 3,000 cycles; they are typically warrantied for only 5 to 8 years. In addition, they are sensitive to temperature fluctuations and often require conditioned space to operate.

Utility and power applications required much higher cycle life – 25,000 cycles or more.

Long-duration flywheels of the type offered by Omnes Energy meet these requirements both in high cycle lifetimes exceeding 25,000 cycles as well as provide high switching times and high power handling capability. Flywheels are vastly superior to batteries for utility energy storage. See attached: Batteries vs Flywheels.

4. What might be the benefits and costs to ratepayers, local governments, and electric public utilities associated with the development and implementation of additional energy storage technologies?

A. Currently, the only technology being promoted is Li-ion battery technology, which is prone to a host of problems as mentioned above. It is important to support other technologies so that NJ ratepayers can have a choice in energy storage methods.

5. What might be the optimal amount of energy storage to be added in New Jersey over the next five years in order to provide the maximum benefit to ratepayers?

A. 100 MW of 4 hours duration would be the minimum energy storage to be added.

6. **What might be the optimum points of entry into the electric distribution system for distributed energy resources (DER)?**

A. A first step would be the use of energy storage installations for ancillary services such as frequency regulation (FR) since New Jersey is within the PJM grid, which has a long-running program to pay for private operators who plug into their grid to perform FR.

   The second mode for using energy storage, which will provide immediate benefits to the existing utility structure is to use them for demand charge reduction and time-of-use (TOU) load shifting.

7. **What might be the calculated cost to New Jersey's ratepayers of adding the optimal amount of energy storage?**

A. Adding 100 MW of 4-hour electrical energy storage is estimated to cost about $200 million, a relatively modest amount considering that New Jersey has over 18,000 MW of electric generator capacity and 3,421 MW of onsite generation.

8. **What might be the need for integration of DER into the electric distribution system?**

A. DER integration into the distribution system will suppress brown-outs and permit the phase-out of fossil burning generation.

9. **How might DER be incorporated into the electric distribution system in the most efficient and cost-effective manner?**

A. The most cost-effective and efficient way to incorporate DER into the electric distribution system is to focus first on large industrial and commercial users of electricity since the payback is much faster. This is particularly true with operational storage modes such as FR and demand charge reduction since benefits can be seen immediately. With renewables, there is the additional time and cost of constructing renewable generation sources which may be done in a second phase of DER integration.

In addition to the legislatively prescribed questions above, please also respond to the following questions:

10. **In the context of the ESA, what might be the definition of Energy Storage?**

A. Energy storage can be defined as follows: The storage of energy captured at a certain period of time and delivered for use at another time. The form of energy captured and stored may be different from the form of energy that is delivered. The energy that is stored may be kinetic (flywheels), chemical (batteries), physical (compressed gas), gravitational potential (pumped hydropower storage), electrical potential (super-capacitors), latent heat (ice), and elevated temperature (molten salts).

11. **What discharge time duration could be applied to the State goals of 600 MW of energy**

storage by 2021 and 2,000 MW of energy storage by 2030? Four hours? Ten hours? Other?

A. Four hours would allow for greater distribution of energy storage resources (ESRs). Mandating ten hours would bias energy storage systems toward very large installations such as pumped hydro which is by its very nature is not easily distributable and has the disadvantages of high transmission losses, regulatory hurdles, long times to implement, and unanticipated expenses.

12. What storage systems should be counted towards the achievement of the State's goal? Existing systems? Those systems placed into operation after the May 23, 2018 enactment date of the statute?

A. New installations after the May 23, 2018 statute enactment date should be counted towards the achievement of the State's goal. PJM currently states that is has 5,300 MW of energy storage resources, of which 96% is pumped hydropower storage. However, it is not clear for how many hours the 5,300 MW is delivered.

13. How might Federal Energy Regulatory Commission's (FERC) Order 841 and the associated PJM compliance filing affect the foregoing?

A. PJM's compliance filing favors pumped hydro which has been the status quo to date. In fact PJM will push back on true distributed energy storage resources that can be co-located at the load (customer) to provide fast implementation and minimizes installation and transmission costs. It may be wise to remove pumped hydro as a DER since it is not a DER!

Sincerely,

Dr. Hari Dharan
CEO/CTO Omnes Energy
(510) 812 4733
hari@omnesenergy.com