

## Energy Storage: Why So Few Pay Attention (and what we can do about it)

Jason Makansi (Pearl Street Inc, St. Louis, Missouri, U.S.A.); JMakansi@pearlstreetinc.com  
Septimus van der Linden (BRULIN Associates LLC)

Energy storage technologies represent a broad portfolio of solutions which optimize the electricity production and delivery value chain within an envelope of constraints that includes the following: (1) The grass-roots demand for significant increases in emissions-free renewable energy, (2) the need for our electricity grid to reflect the nation's homeland security vision, (3) a reliable electricity delivery system that is smart and secure, (4) the need to reduce the impact of a high energy commodity price environment on the economy, and (5) the long-term movement, albeit in fits and starts, to a competitive electricity market.

Yet, so few in the industry seem to care about energy storage. The energy storage sector is held together by a minimal budget and line item at the Department of Energy, two state-driven R&D programs, and a handful of utilities that continue to fund R&D projects. Wind energy is supported by renewable portfolio standards and production tax credits, coal has been supported by billions in Clean Coal funds over a 15 year period, oil and gas enjoys tax exemptions and attractive leasing of federal lands, and even nuclear could take its share of government largesse in the pending energy bill, and is supported through Federal guarantees to manage nuclear waste. This is just the tip of the iceberg listing support mechanisms to other areas of the energy industry.

What is wrong? What is needed? The authors present a case for strengthening the role of energy storage by developing a credible blueprint for industry support with the following elements:

- A committed, consistent public policy presence in Washington DC
- A vocal and defensible analysis of what the benefits of storage are, why they deserve legislative support, and what specific subsidies/inducements are needed by state and federal governments
- A dialogue with the large industry players at the highest levels to encourage one or more of the "big dogs" to create a footprint in storage.
- A broad communications program to present simple messages reflecting energy-storage business cases to leading utilities, ISOs and RTOs, project developers, etc.
- Apply and demonstrate ready to go concepts.

The organizational or institutional framework to achieve these objectives hardly matters. The fact is, every energy industry sub-sector must cooperate to communicate non-engineering, non-technical messages to policy-makers and the C-level executives (CEO, CFO, etc) and the grassroots. A fragmented, technically-oriented collection of narrow special interests will not "lift all boats." A top-down strategy must complement the more technical bottom-up strategy.

### Background

This paper focuses largely on compressed air energy storage (CAES) because the authors feel that this is the only option that is currently practical for bulk energy storage applications.

Pumped storage hydroelectric (PHS), of which there is more than 20,000 MW in the U.S., has proven the benefits of bulk energy storage but is no longer feasible because permitting is next to impossible. Other commercial, ready-to-go concepts are needed. At the present time, around 2% of the nation's electric generating capacity is represented by PHS, along with the lone U.S. compressed-air energy storage (CAES) plant operating in Alabama. Several large CAES projects have been under development, but the progress appears to be one step forward, two steps back.

Of the many applications for storage, wind energy is perhaps ideally suited for integration with storage. We believe it is essential to get wind + storage systems demonstrated and operational at medium or large scale. For example, sub-surface compressed air energy storage (SS-CAES) can be readily and cost effectively demonstrated today for applications between 10 and 100 MW.

Another intriguing idea is to re-deploy machines from the large installed base of under utilized “F” class gas turbines that are available across the country. When combined with storage, these machines can deliver 100MW per unit, cut fuel costs, and lower emissions. Presentations on this subject have been made at earlier EESAT conferences as well as on the potential for bulk energy storage at the World Renewable Energy Council VIII in Denver September 2004[Ref.1]

### **Ideas from Europe**

As a harbinger of issues that we are likely to face in the U.S., Germany leads Europe with over 14,000 MW of wind turbine generators (WTG) installed. The issues of grid stability and base load cycling have now fully manifested themselves. The German Energy Agency (DENA) recently organized a conference in Berlin on the subject of energy storage and wind, inviting all large grid operators, power companies, wind energy developers and government officials to discuss this topic. As a note, the first and largest CAES (290/300 MW compressed air energy storage) facility is at Huntorf Germany, near where numerous WTGs have been installed.

At this meeting, there was a broad consensus that storage is essential and will be needed in the future if dependence on wind as an energy source in the supply mix is to be sustained without sacrificing grid reliability. In a subsequent request for proposals (RFP), the German government has solicited ideas for modifying the present energy feed-in law (essentially a mandate for renewables), so that storage is rewarded in the same manner that wind and renewables are encouraged.

One of the issues with wind power is the intermittency of this supply. To state it simply, an electricity supplier cannot rely on 500 MW of wind generation to serve 500 MW of base-load demand. Because of the intermittent nature of the resource, a larger number of turbine/generators is required to compensate. Storage reduces significantly the number of machines necessary to provide base-load support, with the additional benefit of storing “spillage” when wind turbine generation is curtailed by blade pitch control during periods of excess wind. To capture the wind potential of the top 10 wind States in the USA will require 375,000 3.0 MW WTG’s @ a constant load of 2.76 MW during 3000 hrs of operation.

Maybe a leaf can be taken out of the DENA notebook, convening a similar conference on wind + storage here in the US by DOE. Proposed systems such as SSSCAES and CAES-CT using existing GT units should be demonstrated, with incentives similar to those enjoyed by the wind Industry. This will not only bring new concepts into play, but also remove any technology risk to investors. More importantly, the benefits to the grid system will soon outweigh the initial cost considerations.

### **Some hard questions**

A conference notwithstanding, surely storage industry proponents need to stand up and ask some hard questions. One related to this issue is this: Is the industry, or the public, better served subsidizing the wind energy industry through the production tax credit (PTC) and state-driven or federal renewable portfolio (RFP), or channeling the equivalent amount of money into development, construction, and operation of large-scale wind + storage facilities to capture the benefits noted earlier? Or, on the commercial side, is the money that will ultimately be spent by investor-owned utilities and the ratepayer for 2x or 3x more wind turbines better allocated toward storage facilities?

Why isn’t anyone asking these questions publicly?

### **Technology advances**

With some technology advancements, the benefits of storage expand, and the questions become more urgent. For example, advanced adiabatic CAES concepts integrated with wind energy are progressing in Europe. Will the U.S ultimately have to buy the technology from Europe? Every 100 million kW/hrs captured from wind generation represents 90,000 tons of CO<sub>2</sub>.

Among other benefits, adiabatic CAES reduces the emissions (even though relatively small) from the gas-fired assist necessary in conventional CAES. Here’s how: In CAES plants, the compressed air is cooled before injection into a storage cavern, and the heat removed is normally rejected to atmosphere. Extracting this heat and storing it separately as thermal energy (TES) allows the stored air to be heated prior to expanding in the

power generating turbine, thus reducing the need for additional heat input from natural gas. By the way, this is not a new concept; however, the renewable energy benefits offer a new imperative for its demonstration.

Studies and development work in Europe on another version, AA-CAES (involving adiabatic compression and adiabatic expansion) are progressing. These cycles integrate component development on compressors discharging air at 650C, heat storage devices, and expansion turbines suitable for fast start and ramp rates. Studies have identified and focused on 30 MW -150MW and 300 MW units [Ref. 2]

This is one of the longer term developments the USA should also pursue, while other developed but not demonstrated systems are implemented to start a new phase in the US Power generation, that being Energy Storage.

### **Where is the urgency?**

And so, we come to the most fundamental questions of all that should be posed to this gathering of technical specialists: Why isn't energy storage RD&D funded as if it is a national imperative? Shouldn't energy storage be the *centerpiece* of DOE's efforts to modernize the grid and secure the nation's electricity production and delivery infrastructure?

A careful review of the federal budget and energy programs and policies clearly shows the lack of priority given to electric energy storage. A studious reading of the recently passed energy bill should cause alarm among everyone at the EESAT Conference. Billions of dollars in direct funds, subsidies, and tax credits have been handed out to renewables, fuel cells, coal, oil/gas, and transmission infrastructure. Energy storage is mentioned in passing under a section devoted to new technology credits.

As a reminder, this meager language in the bill was only inserted through the diligent efforts of the Energy Storage Council (ESC), a DC-based public-policy organization *which is no longer funded by the storage community represented at this conference.*

Where is the public policy leadership? The advocacy? Is it coming from EPRI? DOE? States like California and New York (with modest storage R&D programs)? No major industry player (of the stature of GE or Siemens) pushes energy storage in the U.S. No electric utility supports storage as an integral part of its business strategy, only as an R&D line item. No Regional Transmission Organizations (RTOs) or electricity markets apparently view storage as necessary for reliability or market stability. No project developers define storage as their "sandbox." Development activities to date have been one-offs.

Contrast this to wind. The American Wind Energy Association (AWEA) has been aggressively pushing wind for at least two decades. The PTC and RPS at the state level did not happen overnight; it took years of public policy effort. GE aggressively develops wind turbine technology. FPL Energy and PPM Energy, among others, provide deep-pocket wind project development capabilities.

Consider what the Gasification Technologies Council (GTC), a public policy organization for coal gasification, has done, with the assistance of aggressive industry majors like GE and Bechtel. Integrated gasification combined cycle (IGCC) is a technology to be reckoned with by anyone planning a new coal-fired power plant. The GTC has spent many years as a backwater DC-based organization before it achieved its present status. Seven hundred people attended the last GTC meeting!

Where is the policy leadership for electric energy storage?

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