**Date: February 12, 2015**

**Company: Sunverge**

**Participants: Nick, Paul, Jon Fortune (Sunverge), Stina Brock (Sunverge)**

Paul and I spoke with Jon Fortune and Stina Brock from SunVerge to discuss their model needs and get ideas on some use cases.  They provided a wealth of information, though they believe their setup is quite different from others and would require considerable customization to model directly with SAM.  Specifically, their feedback:

* They use hybrid inverters, such that the battery is dc attached.  Power from the battery and the panel then are inverted.
* They are interested in load profiling analytics to ballpark load impact estimates.
* Need higher resolution than 1 hour, perhaps 15 minutes
* They are interested in tools that can reflect quality of performance, such as cycle life, the depth of discharge, accurately reflecting degradation & when the battery needs to be replaced.
* From an economic perspective, they are interested in defining how the system operates in order to obtain specific tax credits.
* LCOE for a battery – they expressed interest in this metric
* Battery responsiveness to charge/discharge (ramp rate).

Finally, they were interested in following up with a detailed (2 hour) meeting to walk us through their system.  But, Paul and I determined it may be best not to do this for now, as it may not be relevant to what we need to accomplish.

**Date: March 24, 2015**

**Company: tenK**

**Participants: Paul, Larry Weiss**

Here are some of the features that would be useful to us:

1)      the ability to add energy storage to the DC side of the system as shown in the illustration below,

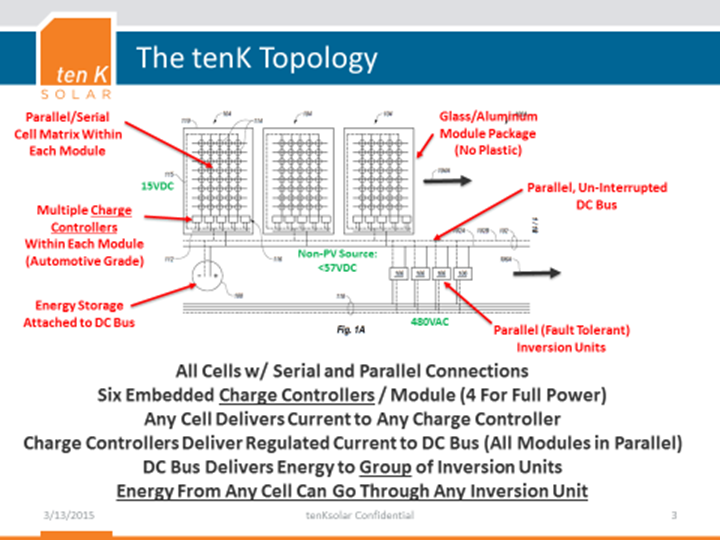
2)      the ability to actively limit output on the AC side to control the storage (much like what SAM has today with DC:AC ratio, but adjustable by hour vs. a fixed value over the year),

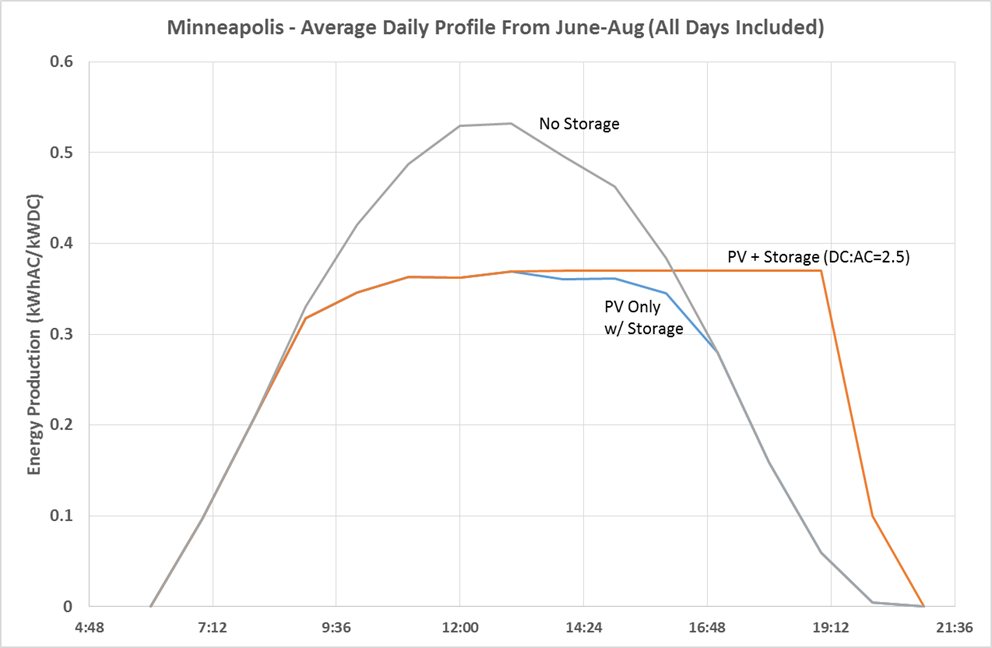
3)      an accumulation parameter for how much energy is in the storage at any time, and

4)      parameters to account for efficiency loss in the battery.

We do not need (at least for now as we can model it with the existing SAM program) the ability to model parallel inversion or the charge controllers in the modules.  As an FYI - the system below operates by:  1) with no storage – the inversion units set the bus voltage by controlling how much current they pull from the bus, the modules produce maximum power.  If the inverters saturate, the system voltage rises slightly and the modules then take control and limit the voltage.  2) With storage – the inversion units have a voltage setpoint at the minimum battery voltage, and the battery pins the voltage during operation (the modules will limit power if the voltage rises above a set value).  The inverters will export at a maximum level if allowed during operation, thus by limiting the AC output full control of the system is possible.

The graph below is an example of what we are working to model in SAM, currently using the 8760 output followed by computations in Excel.  The graph is an illustration of the average daily system output over the summer for an array with a DC:AC ratio of 2.5, and no active control over the AC output.  In this case – excess energy flows into the battery (when the AC output is limited) and then flows to the grid in the later hours after the PV power level drops below the output limit.  There is also sub-hour stabilizing effects going on since passing cloud cover fluctuations are also buffered by the battery without the need for a control algorithm.





**Date: March 26, 2015**

**Company: Strategen Consulting**

**Participants: Nick, Paul, Strategen: Amanda Coggins, Chris Edgette, Shana Patadia**

* They believe some of the most important benefits of storage are those which are not always effectively captured in generic demand charge reduction dispatch scenarios.  For instance, a two-hour capacity battery at some load is more valuable over a six-hour high demand charge period by shaving peaks, not fully discharging in the first two hours.
* Other benefits of storage, which include frequency regulation and reducing ramping are worth considering.
* Storage has the benefit of no start-up cost or minimum run requirements, as opposed to power-generation facilities.
* The company has done work for the California Energy Storage Alliance and is interested in good free public tools advising people in renewable deployment.
* They believe a dispatch model which doesn’t capture scenarios beyond simplistic demand charge reductions may do more bad than good, as it may suggest that storage is not as high a value as it truly is.
* *Warning that model will be misleading if it doesn't show value of storage for peak shaving (requires knowledge of subhourly behavior of PV system and load along with demand charge utility rate data).*
* They've worked with DOE/Sandia on public models for storage optimization.
* A company called Integral Analytics has smart engineers who work on storage optimization and would be good for us to work with.
* Utilities (in California?) have an interest in storage applications for distribution ancillary services (frequency control, peak demand management). PV System owners may use storage to minimize demand charges during peak periods, and then sell other services to the utility during other periods.
* They are willing to work with us informally to provide input and review software versions, but are also interested in more formal collaboration.