Student Poster Abstract for the 2nd
Annual Appalachian Energy Summit Poster Contest

Implementing a Distributed PV- Battery Architecture with Reconfigurable Solar Converter (RSC)

Submission Type: Project	
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Introduction: There are different options for integrating energy storage to a utility-scale solar PV system. Different integration solutions can be compared with regards to the number of power stages, efficiency, storage system flexibility, and control complexity. The novel RSC concept shown in the Fig. 1 arose from the fact that energy storage deployment for solar PV systems has the highest value if there is enough gap or a minimal overlap between the PV power generation and release time (Fig.2). RSC as a single stage converter including both DC/DC and DC/AC operation provides significant benefits over other integration options. After verifying multi-mode operation with RSC, different system benefits of this topology such as peak-shifting and ramp rate control are shown in this paper through describing a single phase distributed multilevel modular RSC. [1]

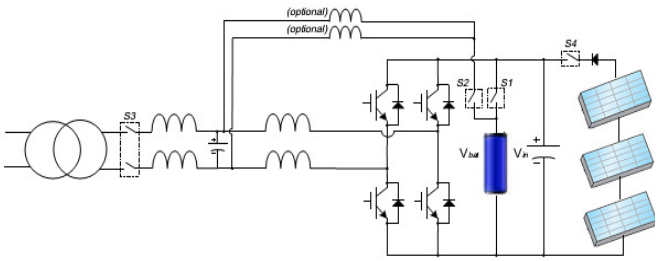

Fig.1. Single Phase RSC.

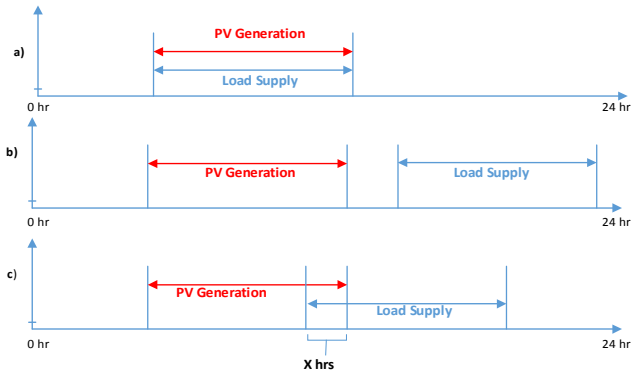

Fig. 2. Different scenarios for PV generation and load supply sequence during a day.

Scheme: The proposed architecture enables more decentralized power accumulation from PV arrays compared to what is deployed today (Fig.3). Simultaneously, with the RSC approach, smaller and different modules of energy storage systems (Fig.4) can be connected to the decentralized PV system. [2-3]

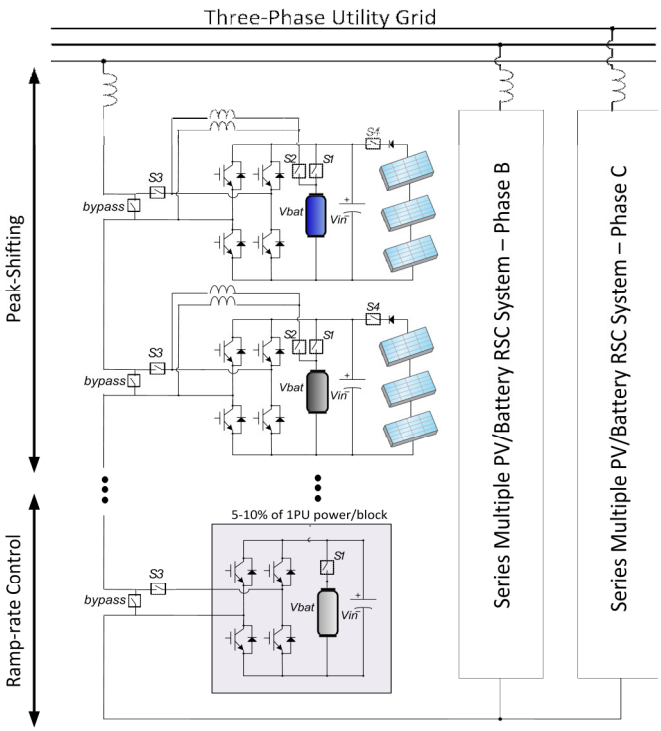

Fig. 3. The proposed decentralized and modular battery/PV integration with the RSC.

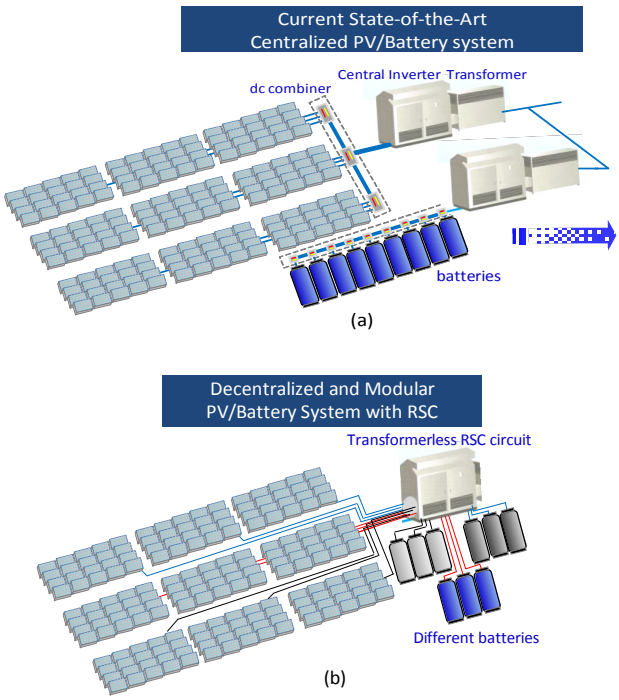

Fig. 4. An example of utility-scale PV/battery system with (a) centralized (b) decentralized, modular battery/PV using RSC.

Preliminary Results: The RSC topology has been implemented to verify the concept (Fig.5). More experimental results, the used ramp rate control scheme, states algorithm (Fig.6), proposed different operation modes such as PV to grid (Mode1), PV to battery (Mode2), PV/battery to grid (Mode3) and battery to grid (Mode4), and interleaving method for the DC/DC operation (Mode 2) will be discussed in detail in the final paper. [1, 4-5]

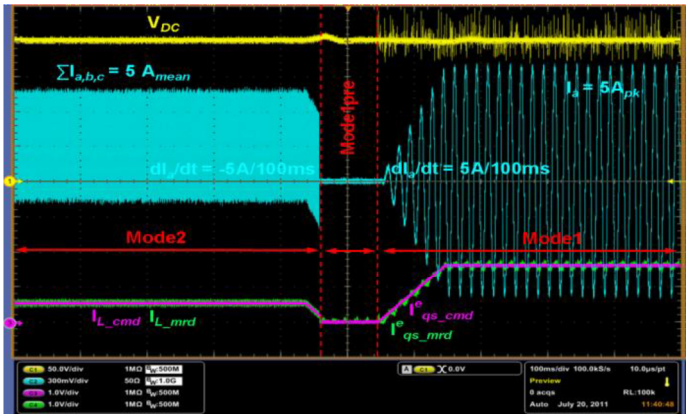

Fig.5. Modes 2 to 1 transient performance.

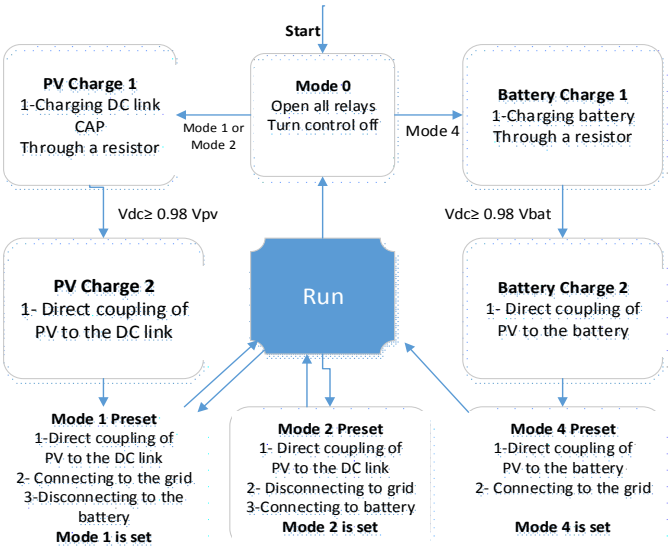

Fig. 6. RSC States algorithm during normal condition

For simulation, five modules including one battery module meant for ramp rate control, configured as a single-phase cascaded multilevel. More details about system specifications will be presented in the final paper.

Results for ramp-down control in which power of each module is reduced 60% of its rated power are shown in the Figures (7-9). The battery working in a discharge mode is inserted to reduce the ramp rate through injecting 30% of rated power. The grid voltage/current and dc voltages are respectively shown in Fig 7 and Fig 8.

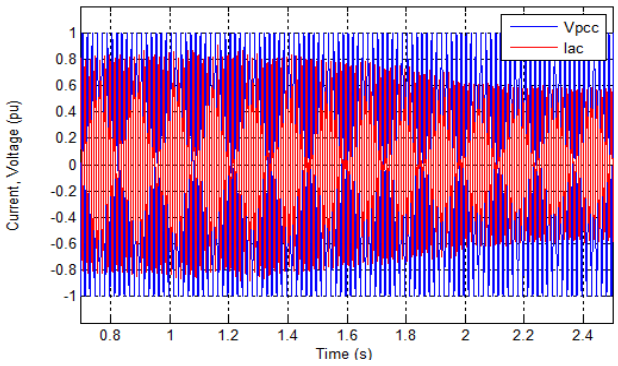

Fig. 7. Grid voltage and current (pu) in ramp-down

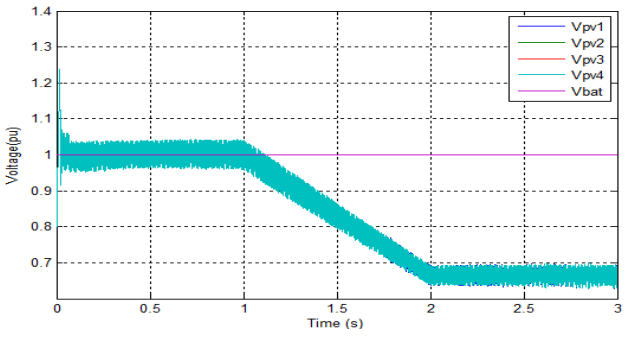

Fig. 8. DC link Voltages for PV and Battery Modules in ramp-down

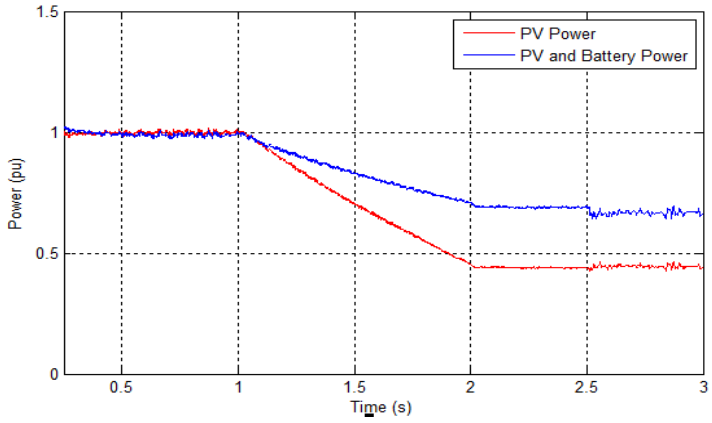

Fig. 9. Grid power (pu) in ramp-down

Conclusion and Future Work: In summary, by using RSC in a distributive transformerless architecture, much more efficient and more cost-effective integration option is obtained to investigate and evaluate batteries through modeling, emulating, and developing the management system, and identifying their direct connection issues. Also, as future work, experimental results of a distributive modular PV/battery integration with the RSC modeled with HIL system including ramp-rate control will be presented.

REFERENCES

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