

Flow-Battery Micro Power storage for off-grid sensor networks

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Micro energy storage systems are ideal for off-grid locations where energy supply is needed during periods without any renewable energy source like sun or wind. While most of these systems rely on conventional batteries — lithium-based batteries being the highest performing — extreme weather conditions, such as intense heat or cold, significantly reduce battery lifespan and performance. Additionally, risks like overcharging and deep discharge can substantially increase the likelihood of fire. This is especially critical in unattended sites, where energy storage solutions must be reliable, safe, require minimal or no maintenance, and offer a long operational life. Redox Flow Batteries (RFBs), particularly Vanadium Redox Flow Batteries (VRFBs), represent one of the most promising and innovative technologies for long-term, robust energy storage. VRFBs can endure deep discharges and overvoltage conditions without notable performance degradation, with an expected lifespan exceeding 30 years. Their modular design allows for precise optimization by separately sizing energy storage capacity and power output. While VRFB technology is gradually gaining traction in large-scale, on-site, and grid-connected applications, a distinct design has been developed specifically for remote sensor networks in agriculture. These systems utilize a planar stacked power configuration combined with external tanks for electrolyte storage. Developed within the PNNR “Samothrace” framework, these systems are engineered to store energy generated from renewable sources. They offer a safe, flexible, and scalable solution capable of withstanding harsh outdoor environments and extreme climates without significant permanent degradation.