

## Second Life Stationary Energy Storage

### The Challenge

When an EV battery is replaced, the used pack typically has about 75% State of Health (SOH). Every option of what to do with the used pack has a cost.

**Warehousing** - Warehouses keep filling up and new warehouses are added to hold more inventory.

**Recycling** - Recovered materials can be reused, but the recycling process is expensive and labor intensive.

**Second Life** - Can require re-engineering of the pack and new control systems designed for stationary energy storage.



In 2014 Nissan donated this used pack to Nuvation Energy to see what we could do with it.



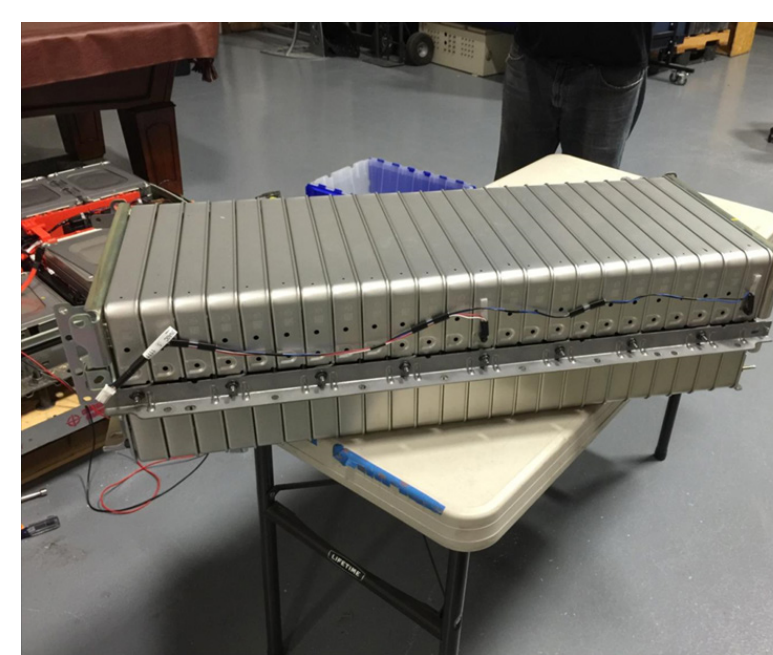
A Nuvation engineer deciding where to start.

### The Opportunity

**Warehousing** - Batteries are heavy and shipping to a centralized location is expensive. But now there are large amounts of them sitting in warehouses.

**Recycling** - Lithium-ion recycling technologies are improving, and with economies of scale the cost will continue to drop. If only we had a way to use the EV packs for a few more years to allow these processes more time to mature...

**Second Life** - Welcome to our Poster, which explores the practical deployment of Second Life batteries in stationary energy storage.



One of Nuvation Energy's first Second Life projects, an energy storage system we named "BESSIE". We took apart the pack, sorted the cells by SOH, and created a new rack and custom battery management electronics. Good learning for us, but not cost-effective.

### Making Second Life Viable

**Need 1** - Configurable, re-usable electronics

**Need 2** - Engineering design that makes Second Life competitive with using new batteries.

The weakest cells in a pack will dictate the overall capacity of a pack, which makes a good argument for disassembly. But an endless supply of used EV packs makes an excellent case for keeping the cells in the pack!



The Nuvation Energy Second Life Pack Controller translates EV pack communications protocols (CAN) to Stationary Energy Storage Communications protocols (Modbus). It also "tricks" the BMS within the pack to think it's still in a car!



In certain Second Life configurations the Nuvation Energy Stack Switchgear (SSG) can connect the second life pack to the DC bus of the energy storage system. In the project example on the right however, the Second Life Pack Controller controls the battery pack contactors, and an SSG was not required.

Our experiment with BESSIE was educational, but there are companies that provide binned cells, and they do the work much more efficiently.



### In Conclusion

**What Do We Need to Make Second Life Viable for Stationary Energy Storage?**

- ✓ Off the Shelf battery control electronics
- ✓ Access to Second Life cells without complex and expensive logistics / shipping
- ✓ Energy Storage engineering design expertise
- ✓ Supply! It is anticipated that over 100 GWh of Second Life cells will be available, PER YEAR, by 2030<sup>1</sup>.

### Project Example

ECO STOR asked Nuvation Energy to design and deliver a containerized Battery Energy Storage System (BESS) that utilized used Nissan Leaf EV battery packs. Nuvation delivered a custom 1MW / 700 kWh BESS that is currently in operation at a utility substation in Norway. Nuvation Energy's nController EMS (Energy Management System) provides demand charge management.



#### Project Details:

- Utility grid transmission & distribution upgrade deferral, substation in Norway
- Nuvation-designed BESS (container, racking, EMS, BMS, thermal management, etc.)
- Nuvation Energy nController EMS (Energy Management System)
- 40 used Nissan Leaf EV packs, one 30kW PCS per pack
- 40' container, 1 MW / 700kWh, 400 VAC



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