

Son-of-a-Buggy Cargo Trailer Conversion

Bill Southworth, August 2012 —I saw Graham Hill's tiny apartment (<http://www.lifefedited.com/about/>) on the Today Show one morning a couple years ago and both my wife and I were struck at the similarity to our little project, Son-of-a-Buggy, a 16' eco-friendly trailer we haul around.

In 2007, I got psyched about a photo workshop in Santa Fe. The next day, my wife and I turned this into a road trip from Maine to New Mexico with two dogs in a Jeep. Traveling like this with a Rottweiler means you stay either in really awful roadside motels or very high end hotels that treat the dog as a guest. We made two decisions after the trip. We swore off states with panhandles for life and decided that we needed a way to carry our hotel with us on our journeys. I checked out all the obvious travel trailer options and decided that they were either too large, too ugly, too inefficient, or too poorly constructed. I decided that I could do better.



I bought a 16' horse trailer and outfitted it with satellite TV, air conditioning, refrigerator, microwave, king sized bed, water tank and heater, shower and a toilet. My wife named it "The Buggy". We traveled 40,000 miles with it on various trips around the eastern US and Canada, including four drives across Newfoundland, Quebec and parts of Labrador.



In 2011, when we heard Hurricane Irene was coming to the New Hampshire coast, we decided to leave The Buggy in Montreal where it would be safe from the storm. Irene had other ideas and passed straight through Vermont into Quebec and felled a tree on the poor Buggy. Total loss.

So I started again on Son-of-a-Buggy. Again, it's 16' long but I made it a foot taller to make room for tankage under the floor. It's a standard heavy duty cargo hauler from Haulmark. I had a couple new goals in mind for it: I wanted it to use the battery and power management technology that we're developing at my company, Hybrid Propulsion; I wanted more water storage so we could travel for a couple weeks without having to find a water source; I wanted solar power to the extent that space would allow; and I wanted to improve the layout so it had an interchangeable "living room", "dining room" and "bedroom", along with a better galley. I also wanted to make waste elimination more friendly by adding a marine-style waste processing system to make the garbage and human waste gray and bacteria free.



I should point out that in our travels we've only stayed in a campground one night. We hated it. We stay now at only the best Walmarts, Cracker Barrels, TA, Flying J and any friendly restaurant or roadside truck stop. This works every place but Florida. But who would want to go to Florida anyway.

Son-of-a-Buggy was christened about nine months ago and we've already traveled about seven thousand miles in it. Everything works great except that the heat pump doesn't work very well when the temperature is below zero. So I'm adding a 75000 BTU propane instant hot water heater which will heat the 200 gallon water tank to room temperature, making a thermal mass to improve the interior temperature. Excess solar power can also contribute to this during sunny days. Actually, because the propane has no pilot and is so efficient, it's actually a highly energy efficient solution, much more than converting generator power to electric heat.



There are other minor tweaks. I've found that a conventional charge controller works better than an MPPT-type controller for charging the LiFePO4 battery bank. The fancier controllers are "too smart by half" for the simpler charge curve of Lithium. Of course all of this is controlled and managed by our Elecyr BMS system and load balancing.

As for the interior of Son-of-a-Buggy, it's pretty similar to the first generation. The cabinetry was done with the assistance of George Beland, a great local furniture maker in Portsmouth NH. I did the design, installed all the systems, and most of the installation. My wife, Barbara, upholstered the ceiling. One over-the-top feature was put in because I needed to balance out the port forward quarter to get perfect trim and tongue weight. It's the concrete counter top built by our friend Joel Tremblay in Granby, Quebec. It's quite beautiful and matches the acoustic carpet which covers the walls.

The galley area has a lot more cabinets than the original buggy and a real countertop for cooking. In addition to the refrigerator and microwave, we've added a Keurig coffee maker, Viking induction cooktop, GE carbon carbon filter for drinking water, and an espresso maker.

The walls are designed in a very Scandinavian minimalist style with very little adornment. The idea is to make the tiny space look larger by keeping the lines very clean and making everything disappear. The walls are all made from a honeycomb material made from recycled cardboard and covered with a thin veneer of birch. We kept the wood light colored to increase the



apparent size of the space. The floors are made from recycled, compressed Mulberry bushes from Sustainable Flooring of Boulder CO (<http://sustainableflooring.com>). It's much harder and more durable than even Teak and we think it's quite beautiful.



The sleeping arrangements still provide for king size accommodation.

The bed consists of one stationary twin which doubles as a sofa. The bolster collapses under the second twin bed which is a horizontal Murphy bed. When the bed is stowed, a drop down table can be slid into place to make a dining area for four, although my wife has made dinner for five work. The 26" Samsung LED TV swings out above the bed for Apple TV or HD DirecTV. The printer, computers and WiFi storage is in the cabinet next to the TV.

We just traveled four thousand miles from

Maine to Key West, where we are installing a Hybrid Propulsion power system in a 120' Schooner. Everything worked great in Son-of-a-Buggy except that I need to tighten up a lot of screws that loosened up battling the potholes of New York. I really believe that New York City streets qualify as off-roading.

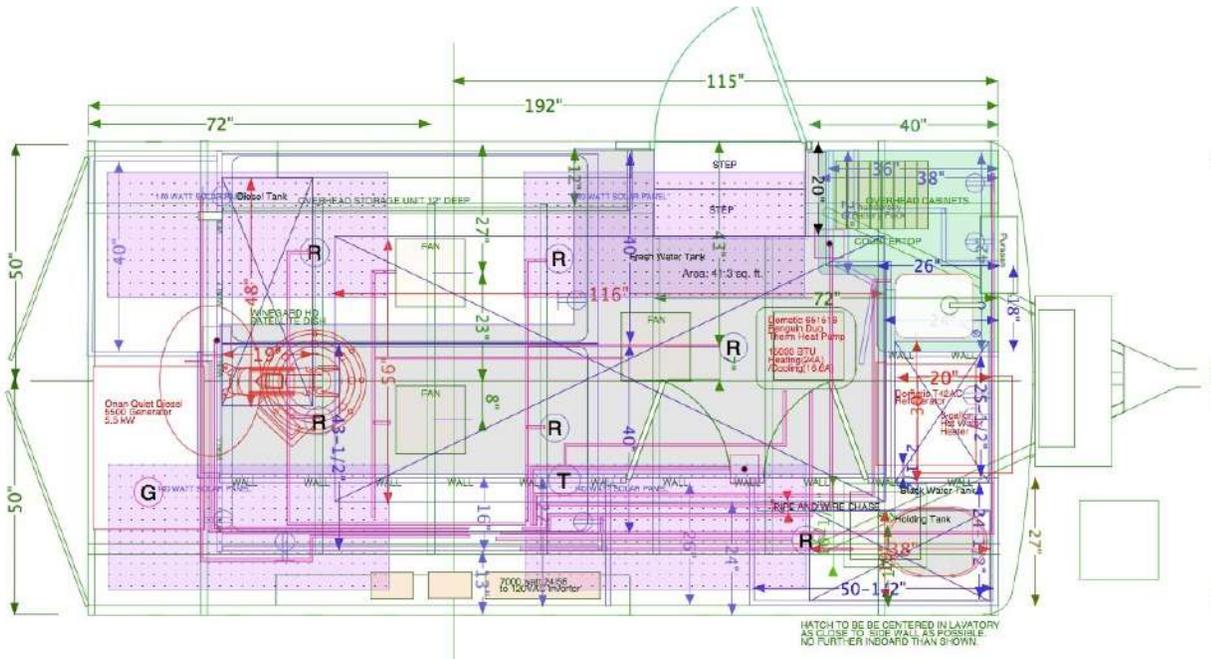
I've attached some photos and I'd be glad to answer any questions anybody has about any of the systems or how I selected them. Total exterior size is 112 sq. ft. Total interior space is a spacious 80 sq. ft.



Update, June 2015 — In the attached files, you'll also find pdf files for the original CAD model of the interior, an Excel spreadsheet for balancing all the components in the trailer, and pdf files for each layer of the CAD layout. I should point out that balancing fore and aft and athwart ship (sorry — I'm a sailor) is critical if you don't want the trailer to sway or wear out your tires. You should design so that there is about 14% tongue weight whether or not the trailer is loaded or empty. The attached spreadsheet is very similar to the type used in ship design. The only real difference is the the capsizing risk isn't as great. However, keeping weight low makes the trailer ride a lot better on turns.

The **electrical system** continues to be a work-in-progress. It's one of the places I test new ideas for control systems, battery management, and living all-solar. I think one of the biggest dangers with any solar power system is undersizing the peak capacity and energy storage. I wanted to run without propane so that I wouldn't have to get rid of the tanks before a ship passage to Newfoundland or the Virgin Islands. Originally, I used a diesel generator salvaged from the Buggy. Currently, the system has been updated with 16kWh of LiFePO4 batteries at 48 volts. An 8kW inverter powers the **air conditioner, heating, hot water, and induction cooktop** and various small AC appliances. If I were to build a "Grandson-of-a-Buggy", I'd use one of the fine DC air conditioner/ heaters from DC Airco (<http://www.dcairco.com/>) or a truck air conditioner /heater from Dometic (<http://www2.dometic.com/enus/Americas/USA/Truck/HVAC-Solutions/Battery-Powered-HVAC-Guide/Choices/>).

Although **heating and cooling** are the biggest energy consumers in an all-electric trailer or off-grid tiny home, cooking is another big user. For this I recommend a microwave of possibly a microwave/convection oven (from Panasonic, LG, or Samsung) coupled with an induction cooktop (I recommend the Duxtop models available on Amazon). With this



combination you can compete with the most well-fitted gourmet kitchen. The microwave and induction cooker are most sensitive to the quality of your 120 volt AC. These are about the only things you'll use that really are happier with a pure sine inverter.

There are many factors affecting your **solar panel design**. If you are traveling for awhile and then stopping for a day or so, then you can oversize your energy storage to store up solar while you are on the road. A pretty small generator can supplement the collected solar. Son-of-a-Buggy has now replaced it's salvaged 5kW Onan diesel generator with a Honda EU3000i gasoline generator. It's lighter, smaller, and much quieter. The only problem with this (and any gasoline generator) is that it has a choke so it can not be auto-started as easily without human intervention. I wouldn't worry too much about panel orientation nor MPPT. Since you'll usually be exposed to direct sun, it's far more important to secure the panels flat without creating extra windage while driving.

The lighting in Son-of-a-Buggy is 24 volt **halogen marine lighting**. Today it would be LED. In recent projects we've used 24 volt **DC LED lighting** from Cantalupi/Zaniboni, i2systems, and Ecolight. Dimmers for DC lighting, especially UL approved ones, are almost non-existent. We use an inexpensive programmable logic controller from Automation Direct. It cost less than a good AC dimmer and provides all the flexibility of a commercial lighting control system costing many times more. I'd be glad to send the PLC software to anyone who'd like to try this.