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# BERRY HILL FARM
## STRATHAM, NH

## FINAL REPORT
## SOLAR VEHICLE FOR FARM USE

NOVEMBER 10, 1994

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### Final Report
### Solar Vehicle for Farm Use

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On June 6th the PVEV (photovoltaic electric vehicle) became a reality. We have used it all summer and fall, with tremendous success. Here is how it was done: we bought a golf cart (a used EZ-GO, with 6 six-volt batteries); we bought 3 photovoltaic modules of 100 watts each; we mounted the modules on aluminum supports bolted to the sides of the cart; and then we connected them to a charge controller, to prevent overcharging, and to batteries located under the bench seat. The modules thus serve as the roof of the cart, collecting energy while they keep us in the shade. Finally, we added a hauling tray on the back to allow us to take full advantage of the 700 pound payload.

Our solar input averaged 7 amps per hour @ 36 volts, for about 5 hours per day (10am to 3pm), or 35 amp hours per day. The EZ-GO cart draws 50 amps @ 36 volts when it is running. Therefore, the cart can run on its own solar power for about 45 minutes per day. (Unlike an internal combustion engine, an electric motor does not use power when the vehicle is not moving, because there is no idling.) We do have an electric charger, but did not have to use it at all once the modules were installed.

We kept a record of the minutes we used the cart each day, and found that we averaged only about 15 minutes per day of actual driving time. This year, being our first year open, our season was short, only 2½ weeks in June. Since we were not open for pick-your-own customers in the raspberry or blueberry patches in July and August, the cart was not used for customer transport, as it will be in the years to come. We found that we will be able to use the cart ***three times as much*** once our plants mature and we can open to the public. Thus its importance to the farm is going to grow and grow.

Our total usage through October was 19¼ hours. Calculating the cart's rate at about 6 miles per hour, we used it to travel about 115½ miles. If we had used the pick-up to drive those same miles, it would have consumed 23.1 gallons of gas. We will continue to use the cart into December with weeding, mulching, pruning etc., so this is not yet a final figure for the year.

Saving time has turned out to be one of the greatest assets of the cart. For many of the minutes the cart was in use, it was carrying us to and from the fields for quick errands. Without the cart, we would have probably walked. To anyone, time saved is a significant plus.

Addressing the other issues that the cart represents for us, we are very pleased with its performance. We find it safe, pollution-free, free of running costs, and very accessible to people with disabilities. We can load it with a 40-gallon trash can full of water, or a tray full of berries, or tools for a full day's work in the fields. People even used it as a shady and comfortable place to rest during the picking hours of the June heat wave. We also find no noticeable soil compaction when we run it between the rows of raspberries for pruning or picking.

We made a big effort to satisfy the outreach aspect of the grant:

1. We gave a demonstration/free picking tour to 40 campers and counselors from Mill Pond Arts Camp (see photo on p. 2);
2. In conjunction with Nada Haddad of the UNH Cooperative Extension Service, we held a Farmers' Twilight Meeting on September 21. Announcements of the meeting were published via press releases throughout the state, as well as in the *Maine Organic Farmer and Gardener* newsletter. Nada also sent an invitation to all the farmers in Rockingham County who are on her mailing list. Approximately 60 people came to view the cart and learn about its construction. We gave each of them a narrative summary and a technical drawing of the completed cart (attached).

3. The attached articles about the cart have been published in *The Exeter Newsletter, the NOFA NH Newsletter, The Natural Farmer,* and *The Maine Organic Farmer and Garener.* Articles have been submitted to two nationwide publications, *Organic Gardening Magazine* and *Real Goods News.*
4. We may offer a workshop on the conversion next summer at the NOFA Conference in Amherst, MA; or the cart may simply be on display with handouts available to all interested.

We are extremely grateful to all of you who helped to make this possible for our farm. We will be happy to demonstrate the cart to any of you who would like to come see it.

Caroline and Buck Robinson
61 Heights Rd. Stratham, NH 03885 603-772-6646

# Article Submitted to Publications
# &
# Technical Drawing

# BERRY HILL FARM

61 Heights Rd.
Stratham, NH 03885
603-772-6646

Caroline and Buck Robinson

Why operate a 4000-pound pick-up to do the job that a solar-powered golf cart can do? Like all farmers, we have many daily transportation needs on the farm. We use GardenWay carts, wheelbarrows, a jeep, tractor and pick-up truck to haul materials to and from the fields. We got to thinking, does this make sense? Inspired by a request for proposal from SARE (Sustainable Agriculture Research & Education), we requested funds to retrofit a used golf cart so that it would be powered by photovoltaic (solar) modules.

We currently grow three types of berries: strawberries, raspberries and blueberries, for both pick-your-own and wholesale customers. We have 2.5 acres under cultivation. We needed the cart for on-farm transportation of tools, materials and berries, and to reduce our use of internal combustion engines. During the hours that our farm is open to the public, the vehicle would also be used to transport customers with disabilities from the parking lot to our berry patches, where, if necessary, they could pick from the cart.

Having had some experience with photovoltaics,we knew that a solar vehicle could do many of the tasks which now require fossil fuels. There were several issues for us here: increase in farm safety due to low speed and low center of gravity; use of renewable energy; reduction of farm-generated pollution; reduction of farm costs; reduction of soil compaction through use of a lighter vehicle; and finally, improved access for people with disabilities and elderly customers.

Fortunately, the project was funded. The cart was retrofitted on June 6th and we have been using it all summer. We call it the Solar Surry or the PVEV (photovoltaic electric vehicle). Here is what was involved: we bought a golf cart (a $500 used EZ-GO, with 6 six-volt batteries); we bought 3 photovoltaic modules of 100 watts each (total $2100); we mounted the modules on steel supports bolted to the sides of the cart; and finally connected them to a charge controller ($180), to prevent overcharging, and to batteries located under the bench seat. The modules thus serve as the roof of the cart, collecting energy while they keep us in the shade.

Our solar input averages 7 amps per hour @ 36 volts, for about 5 hours per day (10am to 3pm), or 35 amp hours per day. The EZ-GO cart draws 50 amps per hour (@ 36 volts) when it is running. Therefore, the cart can run on its own solar power for about 45 minutes per day. (Unlike an internal combustion engine, an electric motor does not use power when the vehicle is not moving, because there is no idling.) We do have an electric charger, but have not had to use it since early June when the modules were installed.

We now find that we could have been using the cart three times as much as we do each day. We've kept a record of the minutes we *have* used it, and our total through July is 822. We figure that we saved about 16.5 gallons of gas up to that point. We will use it into December with weeding, mulching, pruning etc., so we hope to save almost 50 gallons of gas during this first year. We also plan to add a rack on the back which will allow us to take full advantage of the 700 pound payload. We are just beginning to tap the potential of this little solar workhorse! We didn't even anticipate the cart's most important benefit: saving time.

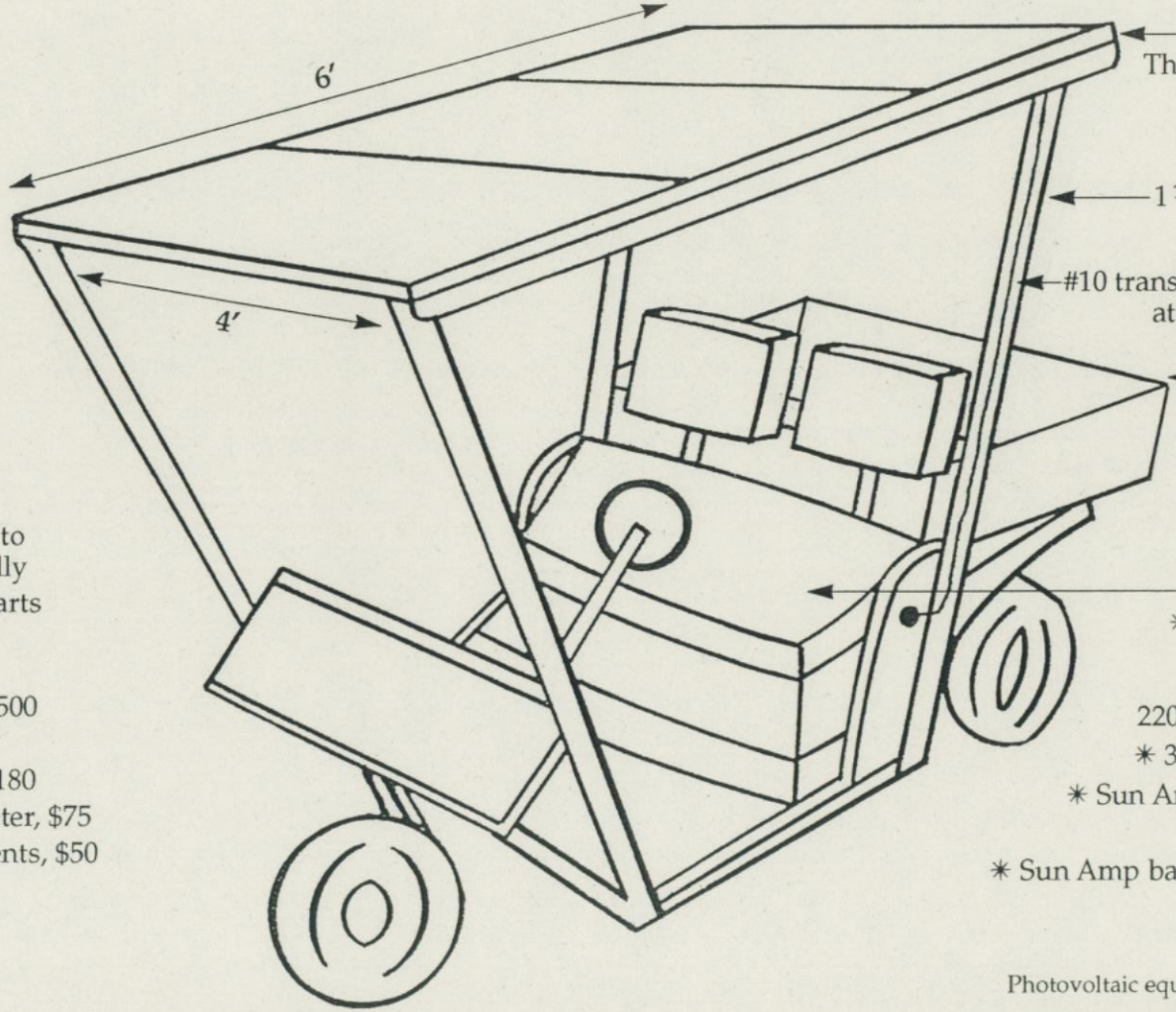
Come see the cart at the Twilight Meeting on September 21st at 4:30 pm. Berry Hill Farm is located at 61 Heights Rd., Stratham, NH (603-772-6646).

Partial funding for the work reported here was provided by a grant from the USDA Sustainable Agriculture Research and Education Program (SARE, formerly LISA).

# PHOTOVOLTAIC ELECTRIC VEHICLE

## PVEV Facts:

- ✳ **100% solar-propelled** since June 6, 1994
- ✳ **Payload:** after conversion, approx. 700 lbs.
- ✳ **Range:** May 1-Sept. 30, 45 minutes of operation per day with solar power only; Oct. 1-April 30, unlimited use with battery charger
- ✳ **Maintenance:**
  - add distilled water to batteries occasionally
  - lubricate moving parts once a year
- ✳ **Material Costs:**
  - used EZ-GO cart, $500
  - PV modules, $2100
  - charge controller, $180
  - battery capacity meter, $75
  - mounting components, $50




Three 100 watt/12 volt Solec PV modules wired in series (each 2′x 4′)

1 ½″x 1½″ aluminum square stock

#10 transmission power cord attached to aluminum

Detachable tray for carrying berries, plants, small tools, etc.

**Hidden from view in drawing:**

***Under bench seat:***

✳ Six 6-volt batteries wired in series, to produce 36 volts for 220 Amp hour capacity

✳ 36 volt electric motor

✳ Sun Amp charge regulator

***On dashboard:***

✳ Sun Amp battery capacity meter

Buck and Caroline Robinson
Berry Hill Farm
61 Stratham Heights Rd.
Stratham, NH 03885
603-772-6646

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Photovoltaic equipment and installation:
Sunnyside Solar Inc.
RD Box 808, Green River Rd.
Brattleboro, VT 05301
802-257-1482 FAX 802-254-4670