SAND2011-3583P

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SNL Photovoltaic Carts

Electric-powered Global Electric Motorcar (GEM®) carts are the main mode of transportation within the technical areas of Sandia National Laboratories, New Mexico (SNL/NM). With the abundant solar energy in the area, the SNL/NM Photovoltaic (PV) Cart Team consisting of Matthew Brito, Erika Barraza, and Israel Martinez from Infrastructure Engineering (4821) and partnered with Darcy Fischer, Diana Goold, and Richard J. Otero of Fleet Services (10265), designed and modified a GEM cart by mounting a polycrystalline panel solar-collector system on its roof that continually "trickle-charges" the batteries and runs the electric motor.

SNL uses GEM carts like the one pictured above and Club Cars (below, left), both powered by solar energy.

A charge controller safety feature turns the system off when the batteries are fully charged, which increases the life span of the batteries. Disconnects protect those working on the cart from electric shock. New batteries cost about $2,100 and can be recycled. A battery on an electric cart usually lasts three years, but the batteries on the PV carts are expected to have a much longer life because of the solar technology used to energize them continuously during the day. Actual battery life and capacity depend on the speed of the cart and the load it carries. The carts have two settings, 15 miles per hour (mph) and 25 mph.

Since solar power constantly recharges the prototype cart, it has been plugged-in only minimally in the more than two years since its initial charging. As a result it is hard to know just how far or long the cart can travel on a full charge. While the cart does not need to be plugged in as long as the sun is shining, on cloudy days the cart can be plugged into an electrical outlet and bypass the PV system. Fully powered by solar energy, the carts need no grid-tied electricity, so SNL/NM does not need to purchase power for their operation. Using an off-the-shelf PV panel and mounting kit, cart modifications can be made in about 30 days at a cost of $2,100 for materials and installation. The retrofit includes a gauge that indicates when power is getting low and how many hours have elapsed since the cart was last charged.

The SNL/NM site also uses electric carts called Club Cars.® Club Cars are already equipped with PV technology when purchased. The SNL fleet now has six PV Club Cars.

The SNL/NM fleet of 300 vehicles contains 156 electric carts. Charging stations for these carts cost about $10,000 each for materials (outlets, circuits, cords, and cord reels), trenching, and installation. Solar carts reduce the need for charging stations, thus reducing the expense for their construction, repairs, and maintenance. Converting carts to solar technology reduces energy costs, lowers pollution rates, and increases sustainability. The OperationsTeam has requested funds to convert the remaining electric carts in the fleet to PV power. Doing so would save substantial amounts of money, reduce grid-tied energy use, increase the use of renewable energy, and reduce greenhouse gas emissions.

At a White House ceremony in October 2010, the SNL/NM PV Cart Team received a 2010 GreenGov Presidential Award, which recognized extraordinary achievement in the pursuit of President Obama's Executive

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Order 13514 on Federal Leadership in Environmental, Energy, and Economic Performance. The awards honor exceptional federal, civilian, and military personnel, agency teams, agency projects and facilities, and agency programs that exemplify President Obama's charge to lead by example in sustainability.

"Sandia's effort in recognizing the need to create a more energy-efficient campus is a great example of the National Nuclear Security Administration (NNSA) commitment to ensuring that we are effective stewards of the environment," said NNSA Administrator Thomas P. D'Agostino. "I applaud the Sandia photovoltaic vehicle team for incorporating technology and solar power to promote energy efficiency."

If SNL replaced its fleet of electric-powered carts with solar-powered ones, huge savings could be achieved. If all DOE laboratories were to follow suit, enormous amounts of electricity, coal, and harmful emissions could be eliminated. Although electric carts might not seem to be a significant source of energy consumption, they are—especially when considered on a national scale. An average cart uses 375 kWh of electricity annually. It takes 2.1 pounds of coal to create 1 kWh of energy, meaning that 787 pounds of coal are burned each year to power one cart. Expand this number to the 300 carts on site, and 236,100 pounds of coal are expended every year to power GEM carts, enough coal to fill a train car.

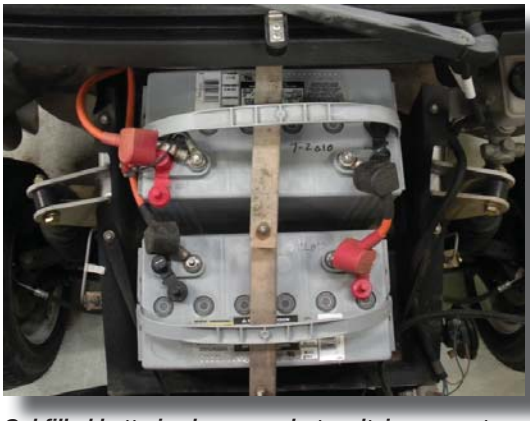
Each kWh of energy created by coal releases 1.408 pounds of carbon dioxide (CO2) and 0.0053 pounds of sulfur dioxide (SO2); therefore, each cart is responsible for 528 pounds of CO2 and 2 pounds of SO2 per year. Multiply these numbers by 300 carts, and 158,400 pounds of CO2 and 600 pounds of SO2 are released each year. It would take 3,850 mature trees (over the age of 15) to sequester all of the carbon dioxide emitted by the carts (each mature tree sequesters about 48 pounds of CO2 per year).

The technology used in GEM carts encourages solar energy use in other SNL/NM areas. Building 833 uses building-integrated photovoltaic (BIPV) solar collectors, also known as "thin film." The thin film is flexible and weighs only about five pounds per square foot, instead of the 35 pounds per square foot of the traditional polycrystalline silicon solar panel used on the cart, but it is not as efficient. The film was installed when the roof was replaced (along with a white membrane and insulation to help fulfill the Department of Energy "cool roof" requirement), and the electricity generated is returned to the electrical grid. The design for converting the Building 956 roof is also complete, and when the roof is replaced, it will use BIPV solar technology and produce about 52 kW of energy.

A shade structure has been proposed to cover the east portion of the Building 887 parking lot and will have PV panels on top. The shade structure will keep the asphalt cooler while the panels produce about 1 megawatt of electricity per year. The entire operation will help reduce SNL's carbon footprint. The coveted shaded parking spaces will be the farthest from the building, so drivers parking there will also increase the number of steps they take each day.

SNL PV Cart Team members Israel Martinez, Erika Barraza, and Matthew Brito take the PV cart for a spin.

Polycrystalline panels collect solar energy that is sent to the batteries.



Gel-filled batteries harness photovoltaic energy to power the vehicles.

Please contact one of the following Operations Team members for more information about PV vehicles at SNL/NM:

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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

National Nuclear Security Administration

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