

# CAFE Energy Committee

## GFC Energy White Paper

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Please refer to the Green Flight Challenge Team Agreement as well as to the FAQ page for any questions about the following Energy Measurement protocol.

See: [GFC 2011 FAQ](#)

The determination of pMPG for the CAFE Green Flight Challenge in 2011 must be made accurately and fairly for all teams. To ensure this, the CAFE Energy Committee has developed the following measurement methods.

**For All Aircraft:** CAFE reserves the right to inspect all parts of the aircraft to ensure safety and fairness. This may entail the removal of inspection panels, cowling, access covers, etc. A thorough search of each aircraft will be made by CAFE officials for any hidden energy or fuel sources.

The flight crew, pilot and all of their accessories as well as the aircraft will be carefully inspected and weighed before the flight. The Competition Weight defined by each team will be the takeoff weight for each of their aircraft's flights during the GFC. After the flight, the aircraft, crew and accessories will again be weighed and accounted for.

After officially impounding the aircraft for the GFC, modifications to the aircraft (other than re-fueling or recharging) will not be allowed. The pit crew area will be monitored and surveilled throughout the duration of the GFC.

**For Battery Electric Powered Aircraft:** The ideal

pre-flight SOC will be determined in advance by each team and "topping off" the battery charge just prior to the flight will be allowed equitably to all teams with electric powered aircraft.

CAFE official(s) will be present at all times during battery charging. Battery charging time will be limited to no more than 16 hours for each team. Team must supply a battery charger for their aircraft that accepts a CAFE-supplied input power source of 240V at 40 amps (9600 watts continuous, from a diesel generator on site). This battery charger can be a ground cart that does not fly on-board the aircraft. The charger must be able to safely and properly control and monitor the charging process by sensing battery condition as measured by an on-board Battery Management System (BMS). CAFE will provide the 240V at 40 amps by way of NEMA 14-50 receptacles.

The NEMA 14-50 plug is for single phase 120/240V only. Use of this connector for anything else is both unsafe and a violation of wiring codes. It is wired as follows:

- Pin G: Ground
- Pin W: Neutral
- Pin X:
  - \* 120 VAC 60 Hz with respect to Pin W
  - \* 240 VAC 60 Hz with respect to Pin Y
- Pin Y:
  - \* 120 VAC 60 Hz with respect to Pin W
  - \* 240 VAC 60 Hz with respect to Pin X

It is permissible to draw no more than 40 Amps each from Pins X and Y. The connector is specified for 50 Amps but we allow only 40 Amps.

Here are a couple links for reference:

[Leviton Products](#)

[Leviton Receptacles](#)

CAFE plans to record the total kWh of electricity use during the flight by using an 'eTotalizer' device coupled to a recording small Netbook computer that also records GPS position and speed. Teams will be asked to pre-install the eTotalizer in their aircraft so that its signal-out leads are safely accessible in the cockpit.

**For Liquid or Gaseous Fuel Powered Aircraft:** CAFE must be able to accurately determine the amount of fuel used by each aircraft. Weighing the very small amounts of fuel that will be consumed in the GFC so as to fairly apportion scores that differ by less than 1% will demand the use of special high-accuracy electronic scales. CAFE will allow either of two methods for determining liquid

fuel consumption. Both methods will require that CAFE supply and fuel each empty aircraft with a requested and carefully pre-weighed amount of approved, traceable fuel before its flight.

Method One will use removable tanks whose measured empty tank weight is no more than 10 times the weight of the fuel consumed. The aircraft can have more than one removable tank and the tank need not be rigid. (Teams obviously should assure that such tanks can be readily removed and installed without any spillage.)

In Method One, the fuel to be used for a given flight will be inspected, sampled and weighed in the removable tank before the flight. The tank will then be installed by team with monitoring by CAFE officials. After the flight, the fuel tank(s) will be carefully removed by team and weighed to determine the amount of fuel consumed. The total fuel consumed must be commensurate with the insensible weight loss of the aircraft and crew and the measured empty weight of the aircraft.

In Method Two CAFE will drain out all remaining fuel after the flight and place it in a small lightweight tank of known weight before weighing it. Aircraft of teams that opt for this Method Two must provide a suitable, accessible low-point drain that enables a convenient, spill-proof complete draining of all remaining fuel. In all cases, the fuel remaining after the flight will be inspected and verified.

The entire path of all fuel supply line(s) and vent(s) from any tank must be accessible for inspection. CAFE will be providing all of the liquid fuels that will be used in the GFC at a 'pass-through' level of cost to each team. Approved fuels are listed in Appendix F. The energy content and density of each fuel must be known quantities for scoring the GFC. If teams would like to use a fuel not already approved for the GFC, they must provide in advance (and possibly pay for) its analysis and documentation by a reputable laboratory and assure that such fuel can be provided in adequate quantity to CAFE for independent approval testing and use at the GFC.

The energy density and pounds per gallon of any bio-fuel to be used in the GFC must be reputedly determined and pre-approved by CAFE. Any combination of diesel fuel and bio-fuel including fuels nominally listed as B100, B99, B20, as well as algae bio-fuels can be used in the GFC once approved by CAFE. However, to win the Bio-Fuel Prize, that bio-fuel must be at least 99% comprised of biomaterial that is not fossil-derived. Note also that to win the Bio-Fuel Prize, a hybrid aircraft must derive  $\geq 90\%$  of its BTU energy consumption from bio-fuel rather than from electricity.

**For Hybrid Electric/Liquid (or gaseous) Aircraft:**

The energy used from both the battery and fuel will be measured as described above, i.e., by weight.

**For Solar Panel Equipped Aircraft:** The energy acquired during flight from solar cells on the aircraft will not be counted as fuel burn.

**For gliders:** There is no prohibition against power-off operation. However, current plans are for the race course to have one photo pylon at which altitude must dip down from the nominal 4000' MSL to be at or below 3300' MSL on each lap.