

energising kids

# SEA'S MODEL SOLAR CAR CHALLENGE 2011

## 2011 REGULATIONS

---

**SEA**  
SUSTAINABLE ENERGY  
ASSOCIATION OF AUSTRALIA  
[www.seaus.com.au](http://www.seaus.com.au)

**Sustainable Energy Association of Australia Inc.**

Street: 48 Lake Street, Northbridge WA 6003

Postal: GPO Box 2409, Perth WA 6000

Phone: +61 (8) 9228 1292

Fax: +61 8 9228 1292

Email: [energisingkids@seaus.com.au](mailto:energisingkids@seaus.com.au)

**Car Specification**

Issue Date 8th February 2011

Section 8 (this document) covers the car specifications

Sections 1 to 7 (a separate document) cover the administration of the event

N.B. All eight sections must be read as a single document.

**Section 8.0 Car Specification**

A synopsis of the Car Specifications is given on page 5. It is essential that you refer to the full specifications in the DETAILED CONTENTS for complete details of all specifications.

**CONTENTS**

<b>8.0</b>	<b>CAR SPECIFICATIONS.....</b>	<b>1</b>
8.1	Test criteria .....	1
8.2	No commercially built cars.....	1
8.3	Size limit .....	1
8.4	Source of power .....	1
8.5	Solar array and support structure.....	1
8.6	Array structure removal.....	1
8.7	Non planar arrays.....	1
8.8	Solar array wiring. ....	1
8.9	No devices on the array .....	1
8.10	Power measurement.....	2
8.11	Temperature correction.....	2
8.12	Power limit .....	2
8.13	Array and array support structure weight. ....	2
8.14	Use of electronic devices. ....	3
8.15	Ballast.....	3
8.16	No energy storage systems .....	3
8.17	ON/OFF switch .....	3
8.18	Car wiring .....	3
8.19	Motors.....	3
8.20	Wheels .....	3
8.21	Steering .....	4
8.22	Removable Drag Plate.....	5
8.23	Body/ Chassis .....	5
8.24	Side Panels .....	5
8.25	Solar panel cover.....	5
8.26	School and Car Name .....	5
	<b>SYNOPSIS OF CAR SPECIFICATIONS.....</b>	<b>6</b>

## **8.0 CAR SPECIFICATIONS**

### **8.1 TEST CRITERIA**

Unless otherwise specified all references to car behaviour and measurements will assume that the car is on a flat, straight section of the track, and in full racing configuration.

### **8.2 NO COMMERCIALY BUILT CARS**

Cars must not use any part of the chassis or body of any commercially available model car. This only refers to the structural frame and body, not to the drive train components such as gears, shafts, wheels, tyres, or to suspension and steering components.

### **8.3 SIZE LIMIT**

Maximum car size allowed is 550mm long, 180mm high and 320mm wide and at no time may any part of the car extend sideways more than 190mm from the centre of the guide rail.

### **8.4 SOURCE OF POWER**

Only commercially available silicon photovoltaic cells are allowed.

### **8.5 SOLAR ARRAY AND SUPPORT STRUCTURE**

The solar cells connected together to provide the power which drives the car will be referred to as the array. The complete unit on which the photovoltaic cells (the array) are mounted is the array support structure. The thickness of the array and its support structure must not exceed 30 mm. The structure must be robust enough to enable handling by the scrutineers and officials. The organisers will accept no responsibility for any damage to the solar cells or the solar array.

### **8.6 ARRAY STRUCTURE REMOVAL**

The array and its support structure must be easily and quickly (less than 2 minutes) removable from the car for testing and ballasting purposes. And when removed the car must be capable of free and stable movement.

### **8.7 NON PLANAR ARRAYS**

Curved, stepped or multi-planed arrays must be able to be re-configured such that when placed on the flat light box measuring surface, no part of any cell is more than 30 mm away from that surface. The scrutineers will calculate a maximum power value for non-conforming panels.

### **8.8 SOLAR ARRAY WIRING.**

All wiring on the solar array must be visible. All panels must be presented for scrutineering with a pair of connections marked +ve and –ve for connection to the alligator clips on the power measuring equipment. Teams using panels of their own construction or modified commercial panels must provide a wiring diagram. Where the panel has multiple individual sections to allow for series and parallel connection, teams must supply pairs of connections as described above for each section of the panel. The power of each section will be measured and the values obtained added together. All wiring must be carried out with standard copper or tinned copper conductors.

### **8.9 NO DEVICES ON THE ARRAY**

All mechanical, electrical or electronic devices including the ON/OFF switch and any devices for changing the panel voltage must be separate from the array. A plug, socket or terminal block to allow connection of the panel wiring to the car wiring is allowed.

## 8.10 POWER MEASUREMENT

The power delivered by the solar array will be assessed by the scrutineers using a light box. Solar panels presented for testing must produce no more than 25 volts open circuit or 2.0 amps short circuit when tested at 1 Sun (nominal AM 1.5), otherwise they will be assigned the value: Power = (open circuit voltage) x (short circuit amps) x 0.8 watts. Scrutineers will measure the power output of all panels at a Sun level expected to be the average over the duration of the event. The power figure obtained will be used to ratio up to the power expected at full Sun. This full Sun figure will then be used for all further calculations. Artificial manipulation of Fill Factor is prohibited and will result in disqualification of the team involved.

## 8.11 TEMPERATURE CORRECTION

As the power output of a silicon solar cell is affected by temperature, the scrutineers will scan all panels with a non-contact thermometer immediately after power testing. The maximum panel temperature recorded will then be used to standardise the power output to the power expected at a temperature of 25oC using the following formula.

$$P \text{ standardised} = P \text{ measured} + P \text{ measured} \times 0.004 \times (T - 25)$$

Where P = power in watts and T = maximum panel temperature in degrees Celsius.  
Any ballast required will then be calculated using this standardised power rating.

## 8.12 POWER LIMIT

Panels must register a total power of less than 10 watts. Any panel recording a power above 10 watts will have tape applied by the scrutineers covering portion of each cell in the array. Tape will be applied in integral widths of 19 +/- 1 mm until the power is below 10 watts. Fine tuning of final power will not be allowed. Removal of this tape except by the scrutineers is prohibited. Racing without the appropriate tape in place will result in forfeiture of the race and depending on circumstances disqualification.

## 8.13 ARRAY AND ARRAY SUPPORT STRUCTURE WEIGHT.

### Cars USING electronics systems

The minimum required combined weight of the solar array, its support structure and ballast will be calculated using the formula:

$$W \text{ (solar array and ballast) [grams]} = 250 \times (\text{Standardised Panel Power [watts]}) - 900$$

### Cars NOT USING electronics systems

The minimum required combined weight of the solar array, its support structure and ballast will be calculated using the formula:

$$W \text{ (solar array and ballast) [grams]} = 150 \times (\text{Standardised Panel Power [watts]}) - 650$$

The Committee will provide scales to determine array and support structure and ballast weights, measured accurate to +/-5gm.

## **8.14 USE OF ELECTRONIC DEVICES.**

Teams may elect to use electronic circuitry for such purposes as solar panel regulation or motor control. During the time trials (usually held on Saturday) they may decide before each individual race whether to use such devices or not. However they must decide before each round of knockout races whether they will run with or without electronic devices for all races to be held in that particular round. During the final, where the best of 5 races determines the winner, the teams may change to electronics or not after the second heat, but must then stick with this configuration for all remaining races.

At scrutineering, teams will be required to indicate their intention to run either exclusively with or without electronics or their intention to select between electronics or not during the course of the competition. The scrutineers will record the appropriate weight/s on the car and all cars may be check weighed before or after each race. It will be the team's responsibility to ensure their car is correctly ballasted at all times. Any car found to be incorrectly ballasted will forfeit that race. A repeated offence will result in exclusion.

## **8.15 BALLAST**

Any additional weight required by 8.13 to bring the weight of the solar array and its support structure up to the required minimum is defined as ballast, and must be carried on board the car whenever the car is on the track. Teams should have approximately the correct amount of ballast when presenting for scrutineering. Suitable ballast might include such things as sand and fine gravel, nails, etc. Ballast will not be provided by the scrutineers. Ballast must be suitably contained to prevent possible spillage onto the track. Note, any item or material used as ballast must not perform any function on the car when racing other than acting as the ballast.

## **8.16 NO ENERGY STORAGE SYSTEMS**

No energy storage system, whether electrical, mechanical or chemical, which assists in the performance of the car, will be permitted. Capacitors of less than 0.2F and inductors less than 1mH are allowed as part of the electrical system. Capacitors above 0.047F must be discharged immediately before the race.

## **8.17 ON/OFF SWITCH**

Each car must be fitted with a commercial 'ON/OFF' switch, the ON and OFF positions must be clearly marked and the switch must be in a location easily visible by the official starter when the car is on the start line. Note: the starter is on the left hand side, so typically the switch would be mounted on the left hand side or on the top.

## **8.18 CAR WIRING**

Where possible all electrical wiring and electronic modules in the car must be reasonably visible. Teams will be required to explain any wiring going into sealed body areas. A simple block wiring diagram will be required if this condition is not met.

## **8.19 MOTORS**

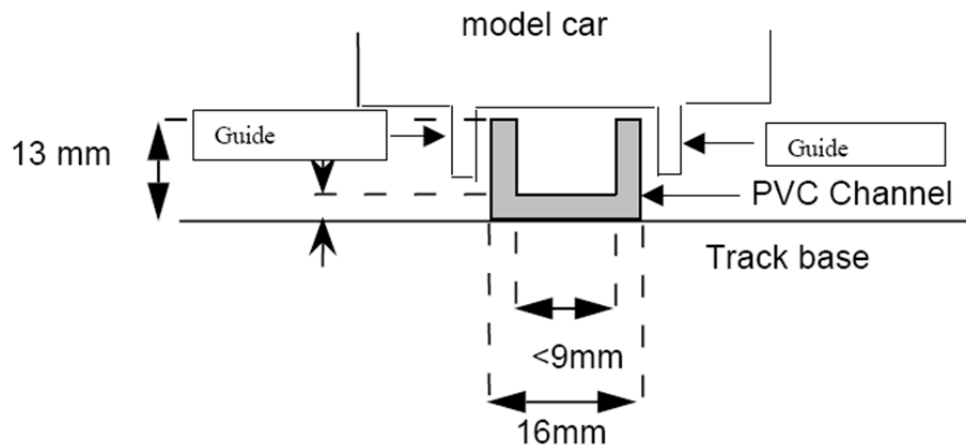
There is no restriction to the type, size, or number of motors that may be fitted to the car. However, the motor manufacturer and/or part number must be made available to the scrutineers for data base information.

## **8.20 WHEELS**

There is no limit as to the number, location, or the diameter of wheels. To reduce damage to the track, knife-edge wheels are not allowed. Each wheel must be at least 1mm wide or have a radius of 0.6mm on the running surface.

## 8.21 STEERING

Each car must incorporate a means of steering around the track. The guide rails as described in 4.3 are approximately 16mm wide and 13mm high. The steering mechanism must be designed to operate on the outside of the guide rail.



The diagram above shows the guide channel and a typical guide layout, the photographs below depict actual guides installed on cars.

The photographs below may be of help in describing what is normally done. Do note however that the guides are usually ball bearings or rollers to reduce friction. It is typical to have 2 sets of guides one at the front and another at the rear.



This photograph of a different car shows how close to the ground guides are normally positioned.

## **8.22 REMOVABLE DRAG PLATE**

The car must include a fixed, flat, rigid, transverse, vertical, rectangular plate of minimum area 200 square cm. and minimum thickness 2 mm. This plate must be easily and quickly removed for measuring during scrutineering. The plate must be one piece and not have any holes or cut outs whatsoever inside the designated area when in place on the car. A drawing of the plate and calculations proving the minimum area are to be presented at scrutineering.

## **8.23 BODY/ CHASSIS**

A car body is completely optional. Any bodywork must not form part of the solar array or array support structure. The body may however form all or part of the chassis. The car must have a chassis or frame with sufficient structural integrity to allow free and stable movement with the ballast and solar array removed.

## **8.24 SIDE PANELS**

The car must have two side panels capable of retaining their shape at all times for attaching numbers and sponsors logos. These must be easily seen by spectators while the car is racing. They will be located one on each side of the car. Each side panel must be capable of supporting a sticker 100mm long and 50mm high. Allowed curvature of the side panels is 20 mm vertically and 15 mm horizontally.

## **8.25 SOLAR PANEL COVER.**

All teams should provide a suitable opaque cover which will completely shade the active area of their solar array for use at the starting position. The use of the cover is to assist the officials detect and eliminate any hidden illegal energy storage devices. The cover must be a flat sheet of rigid material capable of supporting sponsors logos. The use of flexible items such as clothing, towels or similar will not be accepted. If teams do not provide a suitable cover, the organisers will provide a cover of their choosing. The organizers will not be responsible for any problems created by the use of this cover.

## **8.26 SCHOOL AND CAR NAME**

Each entry must have its school name (possibly abbreviated) and car name shown on the car in letters at least 10mm high and visible when racing. These can be attached to any part of the car, other than the side panels.

## 2011 SEA MODEL SOLAR CAR CHALLENGE SYNOPSIS OF CAR SPECIFICATIONS

---

### SYNOPSIS OF CAR SPECIFICATIONS

The following is intended to be used as a quick reference guide only. It contains the important basics but does not cover all the detail. YOU MUST REFER TO THE COMPLETE REGULATIONS FOR FULL DETAILS

- **Maximum body dimensions:** 550 mm long, 320 wide, 180 mm high and less than 190 mm from centre line of guide rail at all times.
- **Wheels:** minimum width 1mm or 0.6 mm radius at contact point with track.
- **Guiding:** must be on the outside of the guide rail
- **Side panels:** one each side, minimum 100 mm long by 50 mm wide.
- **Drag Plate:** a fixed, flat, rigid, transverse, vertical rectangular plate of minimum area 200 sq. cm. and 2 mm thickness. Plate is to be easily removable for scrutineering.
- **School & Car name:** visible when racing, letters minimum 10 mm high not on the side panels.
- **Solar array:** fully removable from car, silicon technology only and no devices mounted on panel.
- **Wiring:** all wiring and electronics must be visible, otherwise circuit diagram required.
- **ON-OFF switch:** commercial switch required easily visible to the starter, on and off clearly marked.
- **Energy storage:** not allowed, except capacitors up to 0.2 farad provided they are discharged immediately prior to race starting. Inductors up to 1 mH allowed.
- **Panel power:** maximum allowed power is 10 watts. Panels producing greater than 10 watts will be masked by scrutineers to produce less than 10 watts. There is no lower power limit.
- **Electronics:** teams must elect to either use or not use electronics systems before each round of knockout races and then stick by this decision during that round. The total required minimum weight of the solar array, its support structure and ballast will be reduced significantly for cars not using electronics.
- **Array and array support structure weight:** will be calculated using the formulas:

$$\text{Total weight with Electronics} = 250P - 900 \text{ [grams]}$$

Or

$$\text{Total weight without Electronics} = 150P - 650 \text{ [grams]}$$

Where P is the panel power in Watts

- **Ballast:** If the solar array and its support structure weigh less than the total minimum required by the appropriate formula above, additional weight in the form of ballast is required to bring the weight up to the required level.