



## **Regulations for the 2020 Event**

September 7, 2020

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The organizer reserves the right to modify these regulations at any time.

## **Acknowledgement**

We would like to thank Chris Selwood and the World Solar Challenge for their great cooperation. They shared their hard work and brilliant expertise with the European Solar Challenge, as well as enabling us to found the following technical regulations on those of the World Solar Challenge. This collaboration stands for joint work and mutual interest in creating a well-functioning and fair event for every participating team.

Also we would like to keep Laurenz Holthoff in memory, who was in the organizer team in previous events but sadly is no longer with us. He did outstanding work until preparations for the European Solar Challenge 2018.

## **1 Administration**

### **1.1 Event Organizer**

Green Technology Events VZW  
Ambachtstraat 18  
BE-3980 Tessenderlo  
info@europeansolarchallenge.eu  
www.europeansolarchallenge.eu

### **1.2 Cancellation of Event**

The organizer reserves the right to cancel or abandon the event for any given reason. The organizer's liability for costs sustained by an entrant are limited to the amount of the entry fee received. In the event that teams are unable to compete in the event despite signing up and already having paid the application fee the application fee will not be refunded. Should the organizers of the European Solar Challenge have to cancel the event, any application or shipping fees will not be refunded.

### **1.3 Insurance**

All team members need to be personally insured for any physiological or property damage that may arise. Please also note that all drivers participate at their own risk and are not insured via the organizers of the European Solar Challenge.

### **1.4 Third Party Property Damage**

Cover has been arranged for any claims against the organizer for damage done by your solar car during the event. All arising costs are responsibility of the entrant.

### **1.5 Entry Fees**

The fees and team limits were adjusted.

- 1.5.1 Application fees amount to EUR 2750, excl. 6% taxes. Application fees cover up to 20 team members. For every additional team member, teams will be charged EUR 20. A deposit of EUR 500 has to be paid in advance before June 1, 2020. Application fees cover participants' usage of the camping grounds as well as the usage of sanitary facilities.
- 1.5.2 An early-bird discount can be achieved by payment of an deposit of EUR 500 of the team in advance until February 29, 2020. The application fees will be then as low as EUR 2250, excl. 6% taxes. Additional team member's fees will apply as stated before. Early-bird registration is only possible and applies until January 31, 2020.

There are no vehicles allowed on the campground other than: Solar cars during pre-scrutineering, support vehicles during buildup and teardown, campervans (as long as their footprint is in proportion to the number of people sleeping inside). Teams who need a support vehicle on the campground should contact the organizers in advance. Keep in mind that the campground might be very crowded. Vehicles may not leave or enter the campground during the main event.

Anyone on the campground must have a fire extinguisher or other method to extinguish a fire nearby.

## 1.6 Pit Box Key

Teams have to leave an EUR 200 cash deposit for the key to lock their designated pit box on their own. The deposit will be returned on Sunday when the team hands their key back to the event organizers. For deposit return the pit box has to be clean and empty.

## 2 Technical Regulations for the Solar Cars

### Legend

Explanatory notes are displayed in shaded boxes.

Notes added 6 weeks prior to the event will be displayed in orange boxes.

Modifications of the rules in comparison to the prior event (European Solar Challenge 2018) are displayed in green boxes.

### 2.1 Vehicle Classes

#### 2.1.1 Challenger Class

Challenger class solar cars are vehicles conforming to the Challenger class specifications defined in these technical regulations.

#### 2.1.2 Cruiser Class

- 2.1.2.1 Cruiser class solar cars are designed primarily for practicality. They are designed to carry two or more occupants, each facing forwards.
- 2.1.2.2 They will be judged on external energy use, the time taken to complete the course, payload carried, and practicality.
- 2.1.2.3 Every vehicle belonging to the cruiser class must be occupied by no less than two people and no more than four people at all times throughout the race.

“and no more than four” was added.

- 2.1.2.4 The combined mass of the driver and its ballast must be at least 80 kg.
- 2.1.2.5 The combined mass of a passenger and its ballast must be at least 60 kg.

### 2.2 Physical Specifications

The following Regulations are compulsory for all participating vehicles, no matter which class they compete in.

#### 2.2.1 Dimensions

- 2.2.1.1 When in motion, the maximum size of the vehicle is 5000 mm in length and 2200 mm in width.
- 2.2.1.2 When seated ‘road ready’ (helmet on, hatch closed), minimum height for driver’s eyes is 700 mm above the road.

## 2.2.2 Construction

- 2.2.2.1 All sharp edges, chains and sprockets must be covered when in use, and internal components or cargo must be secured.
- 2.2.2.2 Adequate ventilation must be provided to all occupants.
- 2.2.2.3 All vehicles shall be constructed or adapted to protect, as far as is reasonably possible, the occupant(s) in the event of collision or vehicle roll-over. Steps should be taken to ensure that vehicle components, accessories or other components do not impinge on the occupant space.
- 2.2.2.4 The design and construction of the vehicle must be such that, in the event of a front-end collision, any part of the vehicle structure (especially the solar array) will be deflected away from the driver / passenger compartment.
- 2.2.2.5 Drivers of challenger class solar cars must be enclosed in a safety cage capable of protecting the driver from an impact of 5 G from any direction.
- 2.2.2.6 Cruiser class solar cars must be fitted with roll bars or roll cages which meet or exceed the intent of the Technical Regulations. All rollbars have to withstand a 5 G impact from any direction. For further details refer to ??.

## 2.2.3 Vision

- 2.2.3.1 Each driver, when seated in the normal driving position with safety-belt and helmet on, must be able to identify 75 mm high letters at every point of forward travel that is:
- 4 m from the driver's eyes, and
  - between 0.4 m below eye level and 0.7 m above eye level, and
  - between 100° left and 100° right of the direction of travel.

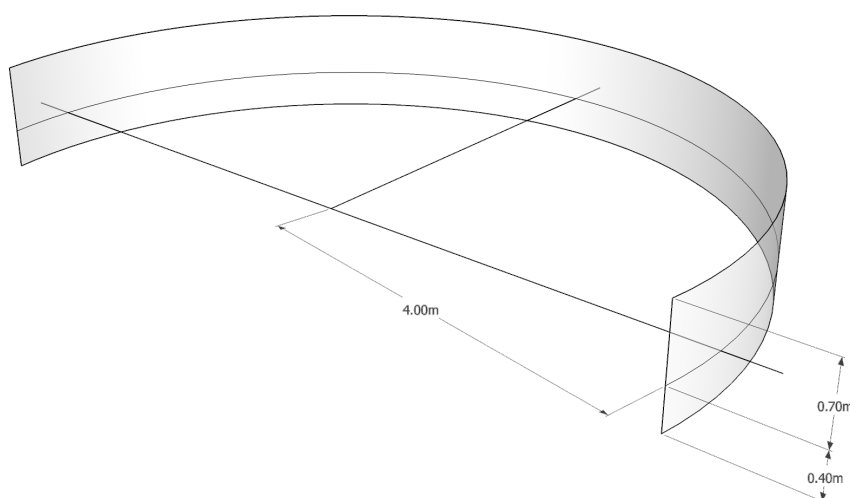


Figure 1: Front vision area

- 2.2.3.2 The driver must be able to see the shaded areas shown in the diagram using the rear vision system (UNECE Regulation 46, Section 15, online accessible at <https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R046r5e.pdf>)

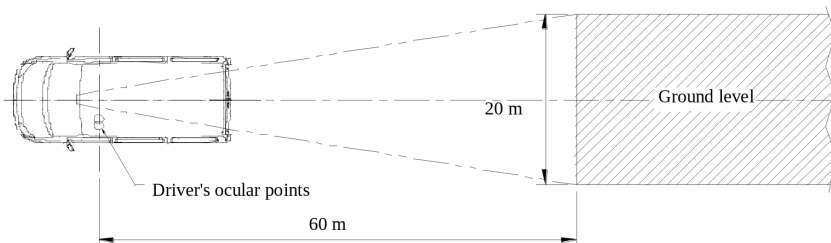


Figure 2: Vision rear mirror

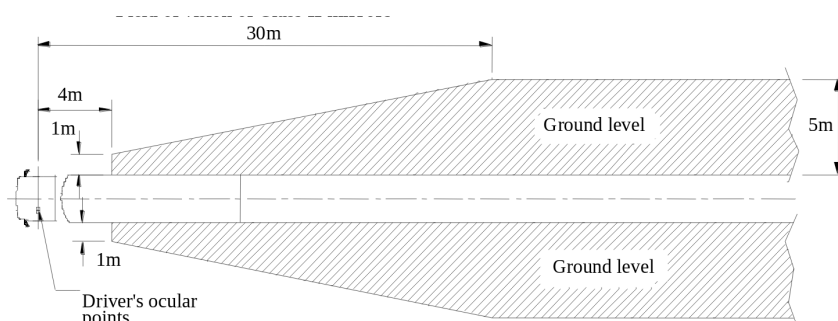


Figure 3: Vision side mirrors

- 2.2.3.3 Rear vision may be electronic and/or optical (mirror). Electronic rear vision systems must operate whenever the vehicle is in motion under its own power.

## 2.2.4 Windows and Windscreen

- 2.2.4.1 All windows must be made of a material that is highly resistant to breaking or major damage. Windows that are necessary to ensure the driver's vision must be made of glass or similar transparent material that does not distort vision.
- 2.2.4.2 The window may not be tinted or coloured to the extent that the condition of the driver cannot be easily observed from outside the vehicle.
- 2.2.4.3 Windows must have an optical transmittance not less than 75% (UNECE Regulation 43).

## 2.2.5 Seats

- 2.2.5.1 Each occupant must be provided with an appropriately constructed seat consisting of a base (squab) and backrest.
- 2.2.5.2 The angle of the (driver's) seat must not be greater than  $27^\circ$ . Drivers must demonstrate the ability to sit, road ready (helmet on, hatch closed), with their back flush against the seating elements measured in accordance with the provisions of ?? of these Regulations.
- 2.2.5.3 Seat belts must be compliant with UNECE Regulation 16, US FMVSS 571.209, SFI 16.1, SFI 16.5, FAI 8853/98 or FAI 8854/98 and have an E or equivalent marking.



Operating a vehicle in an extremely inclined position induces fatigue, prevents the driver from securing sufficient visibility, and may interfere with the effective functioning of the seatbelt in the event of collision.

2.2.5.4 Cruiser class solar cars must have two or more seats, each facing forwards.

## 2.2.6 Doors and Openings

2.2.6.1 Challenger class vehicles must be designed to allow occupants to enter and exit the vehicle without assistance. The doors must be able to be secured and released from both inside and outside the vehicle. Teams will be required to demonstrate that occupants can enter and exit the vehicle unassisted in no more than 15 seconds for each action.

Defining the time of entry is to encourage practicality in the chosen design.

2.2.6.2 Cruiser class solar cars must be designed to allow occupants to enter and exit the solar car without assistance. Doors must be able to be secured and released from both inside and outside the solar car. Entrants will be required to demonstrate that all occupants (one per seat) can enter and exit the solar car unassisted in no more than 15 seconds for each action.

Passengers are not allowed to help each other when exiting the solar car.

2.2.6.3 Emergency opening points must be clearly indicated on the exterior of the vehicle.

2.2.6.4 Securing of any egress route, canopy or hatch with adhesive tape is not permitted.

## 2.2.7 Emergency recovery

2.2.7.1 Solar cars must be equipped with towing eyes mounted as close as practicable to the front and rear extremities of the vehicle, each of which, together with their mountings, must hold sufficient strength to enable the vehicle to be recovered or moved from an inoperable or dangerous situation.

2.2.7.2 The minimum inner diameter of the towing eye shall be 50 mm. Towing eyes must be painted yellow, orange or red. Covers may be used, provided they are removable without the use of tools; and endorsed either with the legend 'Recovery Point' or a graphic representation of a 'hook'. The words or graphic must be in a contrasting color to their background.

It is unlikely that the 'roll bar' would meet these requirements.

## 2.2.8 Brakes

The braking systems for the vehicle should be designed and modelled in accordance with sound automotive engineering practice. Experience has shown that, in general, bicycle type brakes are inappropriate to the application and are unlikely to pass ring. Note that regenerative braking does not contribute to the requirement of a dual-braking system.

- 2.2.8.1 The vehicle must have a balanced, dual-braking system so that in case one system fails, the vehicle can still be stopped safely. Mechanical (i.e. not regenerative) braking effort must be applied to at least two of the wheels.
- 2.2.8.2 The vehicle must be able to stop with an average deceleration of  $3.8 \text{ m/s}^2$  from any speed that the vehicle is capable of travelling. The vehicle must demonstrate the ability to stop in 25 m from 50 km/h and in 12.5 m from 35 km/h.
- 2.2.8.3 All solar cars must be equipped with parking brakes capable of holding the vehicle (including driver and maximum three passengers, if applicable) on an incline of  $18^\circ$ .

## 2.2.9 Steering

- 2.2.9.1 For solar cars, the steering system must be controlled by a steering wheel which has a continuous circumference / perimeter (see also ??).
- 2.2.9.2 Hip lever type steering systems are not permitted in any vehicle.
- 2.2.9.3 The vehicle must be able to make a U-turn in either direction within a 16 m lane (kerb to kerb).

## 2.2.10 Tyres

- 2.2.10.1 Tyres must be suitably designed and rated to withstand the loads and forces imposed by the vehicle mass, speed capability, and braking – especially for highway use.
- 2.2.10.2 Tyres must have a tread pattern across the section width that normally comes into contact with the road, at least 1.5 mm deep in a band that runs continuously around the circumference of the tyre, and must be free of any apparent defect.
- 2.2.10.3 Tyres must, at all times, be used in accordance with their respective manufacturer's recommendations.

2.2.10.4 Under rain or generally wet conditions, appropriate tyres must be used. If the road condition and tyre combination is too slippery, accidents can happen more easily. The organizer has the rights to demand the usage of tyres suitable for the specific weather condition.

2.2.10.5 Rain tyres must provide a minimum depth of 3 mm. Motorcycle tyres likely meet this condition. It has to be ensured that the rain tyres are designed for wet road use and provide enough grip on wet surface.

### 2.2.11 Lights and Indicators

2.2.11.1 Rear brake lamps, front and rear turn indicators, and front and rear hazard lamps are required. These must be visible in sunlight by other road users at a distance of 30 m.

Physically, turn indicators and hazard lights can be implemented to use the same lamps. The modes (turn indicator and hazard lights) are required to be turned on independently from each other, as known from other vehicles.

2.2.11.2 Headlights and red taillights are required and must be visible in sunlight by other road users at a distance of 30 m.

2.2.11.3 Solar cars without appropriate head- or taillights are not allowed to drive during night time.

It is insufficient to use hazard lights as head- or taillights.

2.2.11.4 Lamps must be chosen in a way the car is visible independently of the given light conditions. Headlights also need to provide a good vision for the driver. In case lamps are decided to not be bright enough by observers, the car can be denied to drive until suitable lamps are installed.

2.2.11.5 All lights must be compliant with UNECE Regulations 6, 7 and 37, or the SAE/DOT equivalents. All solar cars need to provide one of the following evidences:

- Compliance markings (e.g., an approved upper case E with respective number inside a full circle) on the lights, or
- detailed documentation that show compliance with the photometric requirements of the UNECE or SAE/DOT regulations, especially the brightness in lumen or lux, confirmed by the scrutineers.

It is extremely dangerous to drive without appropriate light during the night. Especially during the 24 hours race it is expected to be dark on the track for about ten hours. The track is not well enough illuminated to cope with the darkness of the night thoroughly.

### 2.2.12 Horn

An audible warning device (horn, hooter, klaxon, or the like) must be permanently fitted to the vehicle and demonstrated to the satisfaction of the scrutineer.

### 2.2.13 Compulsory Signs

2.2.13.1 The Organizer shall supply signs that carry Event and Event sponsor logos.

- 2.2.13.2 Unbroken, rectangular spaces, 200 mm in height times 500 mm in width must be provided on the right and left sides of the competing vehicle, clearly visible to a person standing 5 m from the vehicle.
- 2.2.13.3 Unbroken space 200 mm times 200 mm must be provided on the right and left sides of the competing vehicle for the purpose of competition number, clearly visible to a person standing 5 m from the vehicle.

These are mandatory requirements. If, in the opinion of the Chief Scrutineer, no suitable place is provided, the vehicle will not qualify for the Event.

## 2.2.14 Timing Transponders

This section was added to the regulations.

- 2.2.14.1 A timing transponder for tracking the race event will be provided by the organizer.
- 2.2.14.2 The transponder has to be fixed below the solar car, at most in 30 cm height above the ground. It must not be subject to falling off while driving, however it has to be removed easily after the race event.
- 2.2.14.3 The timing transponder must be returned to the organizer after the end of the 24 hours race.

Exact details where the transponder need to get mounted will be announced before the event.

## 2.3 Electrical

- 2.3.0.1 All electrical equipment must be well constructed according to sound engineering practice.
- 2.3.0.2 Where the system voltage exceeds 32 V, the vehicle must be constructed in such a way that it is impossible for any occupant of the vehicle to touch live wires or terminals, or for any person working on the vehicle to touch live wires or terminals without having first removed a protective cover.

Example: A motor controller contains high voltage parts, so these parts must be protected by an enclosure or cover. If it is possible to access the motor controller enclosure without using tools (e.g. by opening the boot or tilting the solar collector) then the motor controller enclosure must have a high-voltage symbol on it (see [subsubsection 2.3.3](#)).

### 2.3.1 Isolation

- 2.3.1.1 The driver must be able to electrically isolate the solar panel from the rest of the vehicle while seated in a driving position and without releasing the seat belt. Soft switching (i.e. solid-state relays or MOSFETs in general) is permissible.
- 2.3.1.2 The driver must be able to isolate electrically the battery from the rest of the vehicle while seated in a driving position and without releasing the seat belt. Soft switches are not permitted; the isolation switch must be a circuit- breaker, contactor, or other mechanical type.

### 2.3.2 Emergency Cutoff

- 2.3.2.1 For emergency use, a means of electrically isolating both the solar panel and the battery from each other and from the rest of the vehicle must be provided on the exterior of the vehicle. The activation device must be able to be operated instantly and without hesitation by someone unfamiliar with the vehicle, and without removing any panels or tape.
- 2.3.2.2 Soft switching (i.e. solid-state relays or MOSFETs in general) is permissible for the solar panel. Battery isolation may be effected through the use of a mechanical device inside of the battery pack(s) (as defined in [subsubsection 2.3.8](#)), but can as well be realized incorporating solid state switches or software. In the latter case, teams have to be able to demonstrate that the probability that the realized mechanism fails is less than that of a system with mechanical contactors and switches.

The last two sentences were added (limited allowance of soft-switching the battery into emergency cutoff).

- 2.3.2.3 When the battery isolation switch is 'open', the only live wires permitted to emerge from the battery pack(s) are low voltage control and sensing wires that are short-circuit protected under any reasonably foreseeable fault condition.

### 2.3.3 Signage

- 2.3.3.1 'High Voltage' warning signs must be fitted throughout the vehicle adjacent to all covers which, when removed, expose live wires or terminals where a potential of more than 32 V may be present. The symbol depicted in [Figure 4](#) shall be used, similar symbols are permissible.



Figure 4: High Voltage Symbol

- 2.3.3.2 The activation position of the emergency isolation device must be placed within a yellow disc (minimum 180 mm diameter) clearly marked with a blue equilateral triangle containing a red flash (minimum side length 150 mm), with the legend 'Emergency Electrical Isolation'. In addition, there must be a clear instruction on how to operate the device (e.g., 'PULL' or 'PRESS'). The isolation device must be located within 50 mm of the lower edge of the windscreen on the left side of the solar car.



Figure 5: Emergency Electrical Isolation Sticker

## 2.3.4 Charging Equipment

- 2.3.4.1 A 30 mA Residual Current Device (RCD) must be used.

30 mA was newly specified.

- 2.3.4.2 The charger's output must be electrically isolated from the input.
- 2.3.4.3 Charging must be stopped as soon as a single cell is above its maximum voltage (e.g. 4.2 V).
- 2.3.4.4 A battery monitoring system has to monitor all cell- / module-voltages and temperatures and provide a human readable interface.
- 2.3.4.5 The battery monitoring system must be in operating status while charging.
- 2.3.4.6 The charger's output must be either permanently wired to the solar car's high voltage system or connected to the energy storage system using an appropriate connector.

## 2.3.5 Energy Sources

- 2.3.5.1 Natural solar irradiation received directly by the vehicle is the only external energy source that may be used by the vehicle. For charging with an external power supply see the challenge regulations ([subsection 3.10](#)).
- 2.3.5.2 Energy recovered from the motion of the vehicle may be used.
- 2.3.5.3 Auxiliary panels that are deployed only when the vehicle is stationary, are not permitted.

## 2.3.6 Solar Array Area

2.3.6.1 For challenger and cruiser class solar cars, if the solar collector uses photovoltaic cells the allowable area of photovoltaic cells is:

Class	PV Cell Chemistry	Available Total Cell Area
Challenger	Si	6.000 m <sup>2</sup>
	Thin Film GaAs	3.560 m <sup>2</sup>
	Thin Film Multijunction	3.240 m <sup>2</sup>
	Multijunction	2.640 m <sup>2</sup>
Cruiser	Si	6.000 m <sup>2</sup>
	Thin Film GaAs	4.440 m <sup>2</sup>
	Thin Film Multijunction	4.050 m <sup>2</sup>
	Multijunction	3.300 m <sup>2</sup>

Thin Film Multijunction solar arrays are now allowed.

Challenger class and cruiser class teams wishing to use other types of photovoltaic cells, a mix of photovoltaic cell types, or other types of solar collectors, must contact the organizer. A total proportional sum of the aforementioned total cell areas per chemistry may not be exceeded.

The area of the array will be determined by summing the exposed surface area of the component cells in case the solar cells do not overlap each other. Entrants must supply sufficient information to enable the scrutineers to determine compliance with this regulation. The minimum requirement is documentation showing the size and number of the component cells; the calculations summing the total area; a map with dimensions of the cells as fitted to the vehicle and a written declaration by a licensed professional in the country of origin (e.g., professional consulting engineer) that the array complies with the regulation.

2.3.6.2 If solar cells overlap (shingle), cell area is defined as the total exposed surface area of the cell. Cell area includes active material, busbars, fingers and connection pads.

### 2.3.7 Energy Storage

The following electrochemical terminology is used within both the General and the Technical Regulations of the European Solar Challenge 2020:

**Cell** A device that converts chemical energy into electrical energy by passing a current (a reverse flow of electrons) between a positive and a negative electrode, through an ionically-conducting electrolyte medium.

**Module** A number of cells assembled as the basic unit of a battery pack.

**Pack** A number of cells or modules connected together to provide the required power and energy for a given application. (No more than two packs are permitted.)

**Traction Battery** The total number of cells, modules or packs connected in series or parallel.

- 2.3.7.1 Any energy storage device may be used. The total stored energy of these devices must meet the approval of the Chief Energy Scientist.
- 2.3.7.2 Temporary storage devices other than batteries (e.g., supercapacitors) must be shown to be in a fully discharged state at the Start Line.
- 2.3.7.3 For challenger class solar cars, if the energy storage system is a secondary electrochemical battery then the sum of the nominal cell masses, as specified by the cell manufacturer, may not exceed the following limits:

Li-ion	21.0 kg
Li-polymer	22.0 kg
LiFePO <sub>4</sub>	40.0 kg
Ag-Zn	40.0 kg
Ni-MH	70.0 kg
Ni-Zn	75.0 kg
Ni-Fe	100.0 kg
Pb-acid	125.0 kg

Ni-Cd batteries, other than those used in devices with internal batteries approved by the manufacturer, are not permitted.



2.3.7.4 Teams must provide manufacturer's specifications (datasheet) of the used battery cells that include:

- minimum operating cell voltage
- maximum operating cell voltage
- maximum discharge current
- maximum charge current
- maximum temperature while discharging
- minimum temperature while charging
- maximum temperature while charging

2.3.7.5 If the energy storage system is not made from commercially available secondary cells, the allowable configuration and mass will be determined by the Chief Energy Scientist.

2.3.7.6 Commercially available instruments, computers and digital multimeters may use ancillary batteries provided that the battery is internal to the instrument and complies with the specifications set by the manufacturer of the given instrument. No external connection is allowed to such an instrument battery.

2.3.7.7 Batteries powering vehicle systems and ancillary devices (including computers, telemetry equipment, and non-commercial instrumentation) are considered to be part of the overall energy storage system and will be subject to Technical Regulation [2.3.7](#).

2.3.7.8 Auxiliary Batteries as defined in Technical Regulation [2.3.9](#) are exempt from the definition in Technical Regulation 2.3.7.7

Entrants considering mixing dissimilar batteries should contact the organizer.

## 2.3.8 Battery Isolation

For the purpose of the event, battery packs are defined as the outer container (box) holding a complement of cells / modules, associated internal control equipment, and safety isolation described in these regulations.

2.3.8.1 Battery packs must be housed in boxes with lids (preferably transparent). The boxes must be removable from the vehicle in which they are installed.

2.3.8.2 Battery packs must be constructed in such manner that tamper-evident devices and seals can be applied to ensure that no cell or battery can be removed without breaking the seal.

2.3.8.3 The design of the battery box must facilitate the application of seals by the provision of 3 mm holes through which strings can be passed across the top of the cells within the box.

- 2.3.8.4 Cell / battery monitoring must be conducted by an internal or a remote battery management system.
- 2.3.8.5 Battery packs must be securely fixed to the vehicle.

Fixing by the use of cable ties is unlikely to meet this requirement.

- 2.3.8.6 Chemical spill-proof barriers must exist between the vehicle occupants and each battery pack.
- 2.3.8.7 Battery packs shall be provided with adequate airflow vented to the exterior of the vehicle.
- 2.3.8.8 The traction battery must not exceed two packs.

Entrants with a traction battery that consists of more than two packs shall contact the organizer prior to the event.

### 2.3.9 Auxiliary Battery

- 2.3.9.1 Each solar car needs to be able to provide power to mandatory systems such as emergency lights, even in case of a battery cutoff.
- 2.3.9.2 Thus, it is demanded to carry a separate auxiliary battery pack, which cannot be used as traction battery (this has to be ensured) but may be connected with the lighting system and should be charged from the main battery.
- 2.3.9.3 The auxiliary battery pack needs to last at least for 60 minutes provided there is no charging of the battery (like in an emergency case). Main consumer should be the lights of the cars, therefore the battery must at least be as large as 10 Wh, however at a maximum voltage of 48 V.
- 2.3.9.4 Solar cars have to prove that the head-, tail-, and emergency lights still work for at least 60 minutes.
- 2.3.9.5 Additionally, solar cars have to provide an in daylight visible green light on top or behind the canopy. It has to be at minimum as bright as 20 lumens, which is comparable to a smart phone flashlight.
- 2.3.9.6 This green light has to be flashing whenever the car is in a safe to touch state, i.e., the main battery is cut off safely. This can help rescue teams to decide whether the car can be touched without any precaution in case of an accident or other emergency.

## 3 Race Organization

### 3.1 Announcements

- 3.1.1 Official announcements (e.g. race commission meetings) can be found at the info desk white-board throughout the event and will also be announced via a communication channel over the internet (most probably via a designated “Slack” chat).

Slack was added as a preferred organization communication channel for general announcements. More important (e.g. emergency) notifications however will still be announced via radio.

- 3.1.2 Every team is required to check for new announcements once per hour.

### 3.2 Race Commission

- 3.2.1 Each team needs to pick one member each to join the race commission. As detailed below, the commission will consist of one member from each team and at least one event organizer at all times.
- 3.2.2 Decisions put before the race commission will be decided by majority vote, whereas the race control always holds exactly one vote.
- 3.2.3 One race control member will organize and lead the race commission, but not participate in any voting.
- 3.2.4 Failure to provide a team member to the race commission may result in a team’s immediate disqualification.
- 3.2.5 The task of the race commission is to clarify discrepancies regarding the regulations.
- 3.2.6 Furthermore, the race commission will make all decisions concerning unpredictable influences on the race, such as its termination or interruption due to unfavorable weather conditions.
- 3.2.7 Each team may call for a meeting of the race commission no more than once during the event. For every further summoning, the concerning team will be charged a fee of EUR 500 each.
- 3.2.8 The only exception to the above mentioned requires all participating teams to voice the same objection. For an official application form see ??.

### 3.3 Race Control

- 3.3.1 The task of the race control is the event’s surveillance.
- 3.3.2 Therefore, all communication channels used during the event are required to include the race control. The race control is also in charge of decisions concerning the status of the race track, status of the flags, time penalties, and whether or not a safety car is to be present on the track at any given time.
- 3.3.3 If discrepancies arise teams may contest time penalties through the race control.
- 3.3.4 If the race control decides in favor of the team the existing penalty will be adjusted or withdrawn. Once again the issue will be examined together.
- 3.3.5 The race control may summon the race commission at all times.

Informal complaints not concerning the Race Commission might be directly forwarded to the Race Control. These complaints need to be submitted in written form. A special letterbox for submitting will be made available at the info desk.

### 3.4 Support Vehicles

Without permission from the race control no support vehicles are allowed on the race track.

### 3.5 Safety Vehicles

- 3.5.1 Safety vehicles will be driven by the official event organizers of the European Solar Challenge or by employees of the race track themselves (ambulance).
- 3.5.2 If a safety car is required it will drive on the track's 'slow side'. No two race contestants may overtake one another or the safety car on the track until the safety car reopens the track and returns to the pit lane. In the case of the yellow flag being displayed, overtaking is also not allowed.

### 3.6 Radio Communication

- 3.6.1 Each team has to provide two-way channeled radios, which allow communication between the pit lane and the solar car throughout the race track.
- 3.6.2 Additionally, teams have to rent two handheld radios from the event organizers (cost is approximately 100 EUR, however details on the pricing are announced later). These have to be used in each solar car as well as in the pit box for communication between the race control and the team.

Teams now need to rent two official radios, as before it was only possible to provide one radio per team for communication with race control, leading to some problems. Note, that these differ from the ones specified in regulation 3.6.1.

- 3.6.3 All drivers should understand English sufficiently to understand essential radio commands.

Should a driver's skills in English not be sufficient for the above, the driver's team should contact the organizers prior to the event.

Due to the racetrack's topography, normal consumer radio hardware will unlikely be able to cover the entire track.

### 3.7 Entering the Race Track

Team members are prohibited from entering the track unless access is explicitly granted by the race control. Everyone entering the race track is required to wear a reflective vest at all times.

Drivers and passengers are exempt from wearing reflective vests for safety reasons as these tend to be easily inflammable. Shortly before entering and after leaving the car they however are also required to wear reflective vests.

When in danger, driver or passengers are allowed to leave the car immediately.

### 3.8 Pushing

- 3.8.1 Manually moving the solar car by either pushing or pulling after placing it on its starting position is not allowed. Manual movement is allowed only in the area between the pit boxes and the red line dividing the pit lane.
- 3.8.2 In case of an emergency situation, technical failure, or vehicle damage, the concerning vehicle has to be removed from the racetrack as soon as possible. In this case, teams may manually move their vehicle for the purpose of removing it from the track.

Again, teams are not allowed to enter the track without an permission. In most cases the vehicle will be removed using a tow truck provided by the Organizers of the European Solar Challenge, while assisting team members might get picked up and go together with the tow truck.

### 3.9 Damage and Vehicle Failure

- 3.9.1 If a solar car becomes unable to continue the race, either by breaking down on the track or encountering any mechanical or electrical issues, it has to be removed from the race track as soon as possible. Any necessary repairs can only take place inside the team's pit box.
- 3.9.2 Each solar car has to carry a towrope at all times, so it may be towed by a safety car in case of it breaking down.
- 3.9.3 Every vehicle which is towed off the race track has to be reinspected before entering the race track.
- 3.9.4 If a car stops on the track, the currently unfinished lap will not be counted.

### 3.10 Charging With an External Power Supply

- 3.10.1 During the 24-hour race each team may charge their car from mains twice. Cruiser class cars are allowed to charge more than two times, however this will influence the total energy score as described in ?? ???. Each charging stop has to last no less than one hour. The event organizers will provide a 3 Phase 16A CEE Power Outlet (IEC 60309, 230 Vac, +10%, -6%) for each team.

In case, for instance, an IEC 62196-2 Type 2 socket for charging is required and no possibility can be found to be able to function on IEC 60309 three-phase 16A CEE sockets, the organizers should be contacted by the team at least one month prior to the event.

- 3.10.2 While charging, it is not allowed to fix technical problems or to modify the car.
- 3.10.3 While charging, a solar car's battery containers must remain closed. All High Voltage parts must be protected from physical contact.
- 3.10.4 All single cell voltage and temperature values measured while charging need to be visible to the present observer.

**Teams may actively cool their vehicle's batteries only after proving the measured temperature to be the highest of all cells.**

The sentence above has lead to misunderstandings. During scrutineering teams have to prove that an airflow won't interfere with the temperature measurements in such a manner that a temperature sensor might read a lower temperature than the actual cell temperature.

- 3.10.5 Teams have to hand in a technical documentation of the battery that is going to be cooled including the following information:
  - cell type and manufacturer
  - cell configuration (number of cells in parallel an series)
  - number and type of temperature sensors
  - technical drawing or photo of the battery pack
  - technical drawing of a module (including temperature sensors)
- 3.10.6 All parts that are used to cool the battery have to be fixed to the vehicle and have to stay inside during the entire event.
- 3.10.7 Teams are required to provide their battery safety equipment (including a fire extinguisher).
- 3.10.8 No more than three team members may be present while charging the team's car.

Compliance with the regulations concerning cooling the batteries will be ensured during the scrutineering process.

Charging time is measured from the time at which the vehicle stops in the designated spot until the car leaves the charging area again.

### 3.11 Solar Charging

3.11.1 Teams may charge their vehicle's batteries using solar power at any time. Any alignment of the panels is only allowed in the designated charging area. The charging area's location will be announced during the event.

3.11.2 Charging with supplementary or auxiliary solar collectors is not allowed. This means that only the solar cells permanently connected to the solar car may be used for solar charging.

3.11.3 Solar charging will not affect the energy score of cruiser class cars.

### 3.12 Driver Changes

3.12.1 Changing a vehicle's drivers has to last no less than 5 minutes.

3.12.2 Within this time an observer is allowed to check the function of the vehicle's horn and lights.

3.12.3 Teams shall report their driver changes to the observers one lap in advance.

3.12.4 No more than four teams may switch their vehicles' drivers at a time.

3.12.5 Once a team announces a driver change to the observers, one of the four existing changing slots is immediately reserved for that team.

3.12.6 Once a team announces a driver change to the observers, the team's solar car may not cross the finish line once more but has to enter the pit lane in that lap.

3.12.7 Teams are themselves responsible for avoiding delays caused by all changing slots being occupied.

3.12.8 Teams are furthermore responsible for appropriately scheduling their driver changes, ensuring no driver will drive for more than two hours in a single stint.

3.12.9 Teams may extend two of their stints by a maximum of 15 minutes each or instead one stint may be extended by 30 minutes.

## 4 Safety

4.0.1 All occupants have to wear a helmet at any time inside the car.

### 4.1 Safety Equipment

4.1.1 The teams have to provide the following equipment:

First-aid-box, ABC fire extinguisher (10 kg or more), reflective vests for all team members, battery datasheet, battery safety container and a safety method to extinguish a battery fire.

4.1.2 The solar car's battery has to fit into the battery safety container. The container has to be fireproof.

- 4.1.3 The battery safety container and first-aid-box have to be ready for use in the pit lane. Every team member is required to wear a reflective vest when inside the pit lane or on the race track.

## 4.2 Battery Safety

- 4.2.1 During the event, all battery parameters must be within the limits specified by the manufacturer.
- 4.2.2 The vehicle's power supply has to meet the electrical safety guidelines of the team's home country.
- 4.2.3 During the 24h-race each team has to inform the race control hourly about the following values of their traction battery:
- highest cell temperature
  - lowest cell temperature
  - highest cell voltage
  - lowest cell voltage

## 4.3 Visitors

- 4.3.1 We're always trying to keep the European Solar Challenge an event with lots of room for socializing and exchange of knowledge or expertise. However, private visitors may only enter the pit boxes or pit lanes when registered with the organizers. Furthermore, they are required to wear reflective vests in this area.
- 4.3.2 Additionally, all media correspondents need to register with the organizers in advance. They need to check in at the infodesk on arrival.
- 4.3.3 Visitor passes will be available at the infodesk for free.

Again, teams are not allowed to give unregistered persons access to the pit lane.

## 4.4 Pit Lane Safety

- 4.4.1 The area limited by the pit boxes on one side and the red line on the opposite side is mainly reserved for repairs and modifications, and should be kept clear by private visitors.
- 4.4.2 The area beyond the red line should be kept clear at all times.
- 4.4.3 No tables, chairs, or other temporary constructions may be placed directly alongside the wall dividing racetrack and pit lane.
- 4.4.4 All private visitors to the pit lane are to stay inside the designated pedestrian area.
- 4.4.5 Any vehicle driving on the pit lane must not exceed the maximum speed of 20 km/h. This will be measured at all times during the event.



## 4.5 Clothing

- 4.5.1 Every person entering the pit lane has to wear high visibility reflective clothing.
- 4.5.2 Wearing solid shoes will be mandatory inside the pit lane at all times.
- 4.5.3 Drivers are especially requested to comply with this rule. The driver's clothing should cover the entire body.
- 4.5.4 Clothing should be made of natural fibers and cover the occupants' legs, arms and upper body. Natural fibers are flame-retardant by themselves whereas synthetic fibers can melt and cause dangerous burns on the skin when catching fire.

Overalls or racing suits are highly recommended for drivers.

- 4.5.5 Each car has to provide reflective vests, one per seat (with a maximum of four), to be worn by occupants when leaving the car in a breakdown or similar situation after getting out of the car.

## 4.6 Drugs and Alcohol

- 4.6.1 During the entire event, no participant may consume or be under the influence of any soft or hard drugs.
- 4.6.2 Furthermore, nobody participating in the event may consume or be under the influence of alcohol during the time of the main event.

Smoking is permitted on the balcony behind the doors of the pit boxes and on the way to and on the camp ground, but never on track or inside the pit boxes, as well as the charging areas.

## 5 Scrutineering

- 5.1 Qualification must be achieved in road ready configuration. Vehicles which are unable to present at the designated time or are not ready to start may fail to qualify.
- 5.2 Each team must provide appropriate tools and personnel to facilitate the inspection of structural components.
- 5.3 Checks and inspections with the solar car in a road-ready configuration will include, but not be limited to:
  - Signage
  - Solar car size
  - Solar collector type and size
  - Vision (shortest and tallest driver required)

- Lights, indicators, horn
- Ability to tow the car
- Electrical compliance

- 5.4 The weight of all drivers must exceed 80 kg, of all passengers 60 kg.
- 5.5 Teams are responsible for providing additional penalty weights should one or more of their drivers weigh less than 80 kg (respectively passengers 60 kg).
- 5.6 These penalty weights should be presented inside a container which can easily be sealed by the organizers.

Penalty weights could for instance be made of water-bottles filled with sand. There will be a scale provided in the driver change area to verify the driver's weight before changing the driver.

- 5.7 The maximum number of team members participating in the scrutineering is limited to 7 people.
- 5.8 Qualification must be achieved in road-ready condition. Teams unable to present at the designated time in road-ready condition may fail to qualify.

Teams who fail scrutineering due to a non safety aspect may possibly participate in the event out of competition. The decision will be taken by the official organizers.

## 6 Penalties

- 6.1 The race commission may contest any arising penalties.
- 6.2 Penalties range from official warnings to disqualification from the event.
- 6.3 All penalty times listed are suggested minimums.
- 6.4 Driving conduct may double with each subsequent infraction.
- 6.5 Mathematical penalties will normally be the same for each infraction.
- 6.6 If the inspectors believe that teams are deliberately violating regulations for strategic advantage, they may impose more penalties up to and including potential disqualification.
- 6.7 The race commission has the possibility to protest against the penalties.
- 6.8 Penalties including disqualification from the event may be imposed for improper conduct or the use of alcohol or illegal substances. Improper conduct may include but is not limited to:
- Unsafe behavior
  - Speeding in the pit lane
  - Cheating
  - Improper language

- Unsporting conduct
- Violation of traffic rules around the racetrack
- Driving without properly fitted safety belt
- Distracting Race Control

6.9 Teams or team members may be penalized for disregarding any instructions given to them by the event organizers.

**Teams are responsible for the conduct of all persons associated with the team, whether or not they are officially registered.**

**Pushing** A penalty of one lap will be given to every team who pushes a solar car while on the track. (Except in an emergency).

**Improper Ballast** A five lap penalty may be assessed each time a team operates their solar car with ballast not matching the one assigned to the car's driver or their passengers.

**Unauthorized Drivers** Any solar car driven by an unauthorized driver will be required to return to the pit lane and drive with an authorized driver. Unauthorized driving will not be counted.

**Disturbing Official Battery Seals** Solar car batteries will be marked with an official seal. Disturbing these seals in a manner that prevents proper identification by an observer may be penalized as though all of the battery cells affected had been replaced as handled in the following penalty regulation.

**Replacement of Batteries** Decisions to exchange all or part of a battery must be communicated formally to the team's observer. The penalty will be computed as follows:

- Cruiser cars: The energy score's battery capacity is incremented by two times the replaced capacity.
- Challenger cars: One lap penalty for each 3600 mAh of replaced capacity.

The calculation of battery cell replacement penalty has changed.

**Exceeding Size Specifications** Oversize solar arrays will be penalized one lap per exceeded square centimeter beyond the allowed size specification.

**Restriction on Overtaking** On the track there are three dangerous turns. The restriction on overtaking will be marked with red tire stacks (details will be announced in the team meeting). Dangerous overtaking in these curves will be penalized with a penalty of three laps. Shortcut curves on the green areas beside the track will be penalized with one lap penalty.

**Stopping** Stopping on the racetrack will result in a penalty of one lap. Obstructing other teams will increase this penalty. An exception are unforeseen car breakdowns.

**Slow Vehicles** Slow vehicles not driving on the slow side of the track will be penalized with at least one lap. Obstructing other teams will increase this penalty.

**Blocking Cars** The blocking or hindering of other vehicles out of deliberation or negligence will be penalized with one lap.

**Drugs and Alcohol** Consuming any drugs or alcohol inside the pit lane may result in disqualification of the concerning team member or team.  
People participating in the event must not be under the influence of alcohol at any time.

**Night's Rest** During the main event, all participants are to keep quiet on and around the campsite. In addition, all participants are required to respect a period of rest every day of the event between 11 p.m. and 7 a.m. During these hours, no noise disturbing the other participants will be tolerated on and around the campsite.

The main event begins at Friday, 7 a.m. and ends at Sunday, 3 p.m.

The European Solar Challenge takes place during a low noise weekend at Circuit Zolder. Participants are required to keep excessive noise which may disturb the neighborhood to a minimum.

**Further Penalties** The Race Control may enforce further penalties during the event. Further penalties will commonly be enforced in accordance with a Race Commission.

## 7 Challenges

Chicane, regularity test, and safety challenge were replaced by the dynamic parcours. Thus, the scoring schemes were adjusted.

### 7.1 Challenger Scoring

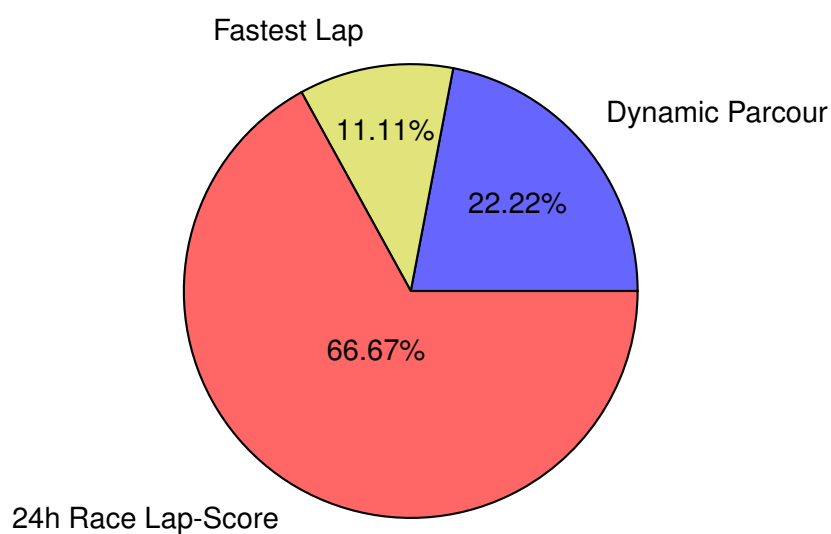


Figure 6: Scoring

### 7.2 Cruiser Scoring

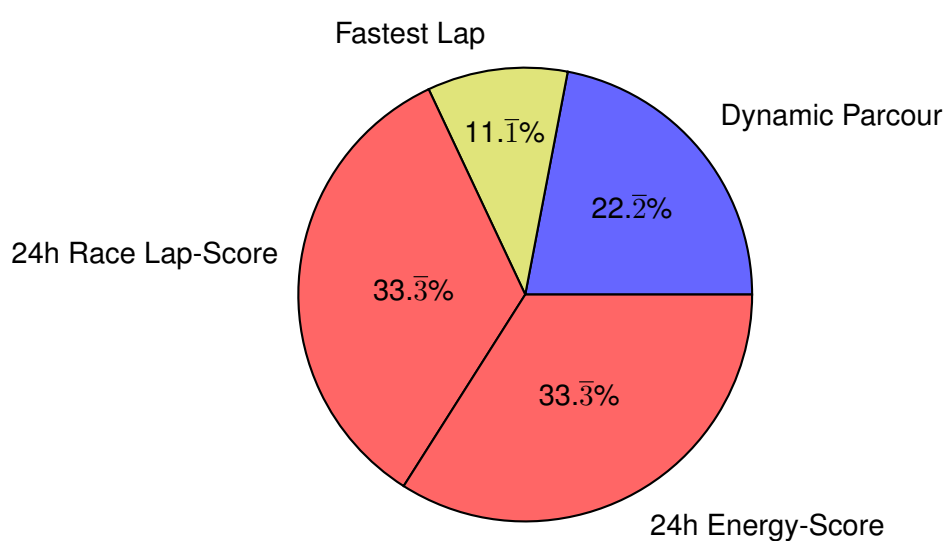


Figure 7: Scoring

The Presentation Challenge was removed for the iESC 2020.

### 7.3 24-Hour Race

7.3.0.1 The 24-hour race starts on Saturday, September 19, 2020 at 13:00 (1 p.m.), and concludes on Sunday, September 20, 2020 at 13:00 (1 p.m.).

7.3.0.2 The race begins with a Le Mans-style start.

7.3.0.3 The order of the line up is predetermined by a raffle before the day of the race.

7.3.0.4 In order to line up for the start, teams are allowed to drive backwards through the pit lane. The line up will be overseen by the observers.

7.3.0.5 At the start, every team may assign one team member to aid the driver while entering the solar car.

7.3.0.6 Every team needs to take their position in the line up no later than 15 minutes before the official starting time of the race.

7.3.0.7 Teams failing to arrive in time for the line up will start from the pit lane and will be penalized.

7.3.0.8 Depending on strategy, all teams may decide for themselves when their solar car exits and enters the track during the duration of the race.

7.3.0.9 During the duration of the race, all repairs or modifications conducted on participating vehicles need to comply with the regulations of the European Solar Challenge. This will permanently be verified by technical inspectors.

#### 7.3.1 Challenger Class

The Team with the most laps driven wins this challenge, for details see ?? ??.

#### 7.3.2 Cruiser Class

The 24h-Race-scoring is divided into two scoring parts. The Points mentioned in ?? ?? will be divided 50/50 for each part.

#### Energy-Score

$$E = \frac{\text{metered energy consumption} + \text{initial battery capacity}}{\text{laps} * (0.5 * \text{passengers} + 0.5)}$$

This formula calculates the energy consumption per lap and takes the number of passengers in account. The energy consumption consists of the capacity of the initial (fully) charged battery in kilowatt-hours and the metered kilowatt-hours while charging from mains power supply on the AC side. The Team with the lowest score wins this challenge, for details see ?? ??.

The energy score is now depending on the metered energy consumption. Metering will be provided by the organizers.

Passengers is the number of people in the vehicle, the denominator of the formula will be evaluated for each stint.

The number of charging stops cannot be zero, the initial charge will be counted as well.

**Lap-Score** The Team with the most laps driven wins this challenge, for details see ?? ??.

## 7.4 Dynamic Parcour

7.4.1 The dynamic parcour challenge will take place on Friday, September 18, 2020. It will begin at 13:00 (1 p.m.) after an open track in the morning and concludes later in the afternoon. Each team will consecutively maneuver their vehicle through a pylon parours around the course. Each participant completes the whole course three times and enters the pit lane entrance again.

Open track will be on Friday morning as well as Friday evening after the dynamic parcour challenge. Details will be announced.

- 7.4.2 The timing measurement starts and ends on the start / finish line.
- 7.4.3 There will be approximately eight slalom styled challenges appearing on the track. These will be marked by gates that have to be passed, consisting out of two pylons between which the solar car has to pass.
- 7.4.4 Each single missed slalom (clearly distinct slalom gate) or over-driven or hit pylon will add 30 s penalty up to the round time.
- 7.4.5 One complete lap has to be driven. For timing, it is necessary to drive one out lap, then the timed lap and afterwards the cooldown / in lap. Details will be announced in the pilot briefing before.
- 7.4.6 All teams will drive around the course, one-by-one. While one solar car is in its cooldown lap, the next car will already drive the out lap.
- 7.4.7 During out lap / cooldown lap it is not required to accomplish the challenge. Missed slalom gates will be counted only during the timed lap.
- 7.4.8 The dynamic parcour challenge will take up to three hours. Arising technical issues may be resolved by the concerning team, also within that time frame. However, each team only has one opportunity to do the challenge.
- 7.4.9 Should unforeseen results be produced in any other way, measures to be taken will be determined by the race commission (see [subsection 3.2](#)).

## **7.5 Fastest Lap**

- 7.5.1 The fastest lap challenge will take place as a part of the 24-hour race.
- 7.5.2 After the race has ended, the fastest lap for each team will be detected. The team with the fastest lap wins the challenge.



## 8 Appendix

### 8.1 ISF Roll Bar Specifications

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All vehicles must be equipped with the first and second roll bars (as shown in the specifications below) to prevent direct damage to the driver and serious cockpit deformation in the event of a collision or of a car turning over.

The first and second roll bars form the basic element of the rollover structure. These structures must be made of steel tubes or other material of sufficient tensile strength to protect the occupant from a force of  $4w$  ( $w$ =weight of vehicle) The structure must be bolted, welded or otherwise structurally incorporated to the vehicle according to sound engineering practice. For vehicles whose bodywork fulfills the function as the first and second roll bars, the installation of additional roll bars is not necessary.

Roll bars shall meet the following dimensional criteria:

- The line extended from the top of the first roll bar to the top of the second roll bar must be above the driver's helmet when he/she is seated normally in the vehicle.
- The top of the first roll bar must be higher than the top of the steering device.
- The first roll bar must cover the steering device with steered wheel(s) in the straight position ahead when the vehicle is viewed from the front.
- The second roll bar must cover the driver's shoulder when the vehicle is viewed from the front. In case that the bodywork of the vehicle covers the driver's shoulder, the second roll bar may cover only the driver's head.
- The second roll bar must have enough strength for lifting or towing with the driver on-board. General descriptions Roll bars must be designed and constructed so that, when correctly installed, they minimize the risk of injury to the occupant. The responsibility to secure the necessary strength rests with competitors. No part of roll bars must hamper the entry/exit of the occupant or take up the space designed for the occupant.

General descriptions

- Roll bars must be designed and constructed so that, when correctly installed, they minimize the risk of injury to the occupant.
- The responsibility to secure the necessary strength rests with competitors.
- No part of roll bars must hamper the entry/exit of the occupant or take up the space designed for the occupant.

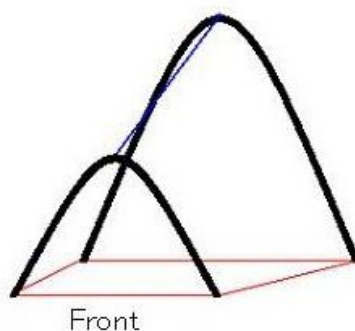


Figure 8: Rollbar: general view

The driver's helmet must, when seated normally, be contained within the defined area

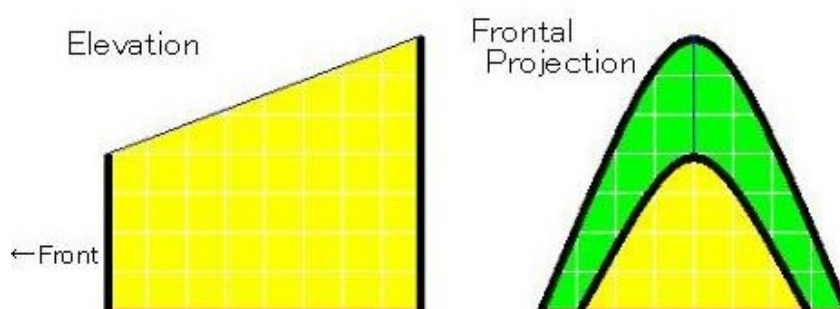


Figure 9: Rollbar: side view

All driving controls must be capable of being accessed and operated within the defined area

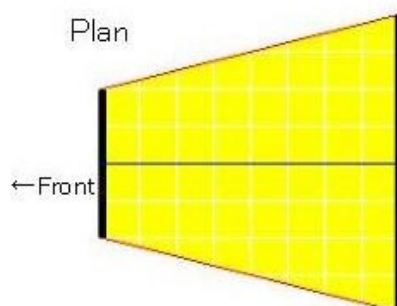


Figure 10: Rollbar: plan

All parts of the driver's body (including any protective clothing and equipment, must, when seated normally, be contained within the defined area)

## 8.2 ISF Standard Measurement of Seating Angle

- The seating angle must not exceed 27 degrees.
- The concept of determining the seating angle is based on the measurement of torso angle in accordance with ISO/JIS Standards.
- JIS D4607 is the standard that shows the three-dimensional seated human model for measurement of automotive body interiors.
- JIS D0024 establishes the H points (hip point: rotational center of body and thigh in the three-dimensional human model) and indicates measurement methods including the torso angle based on D4607.

For ISF scrutineering purposes, measurement is effected by using a template based on the hip and shoulders of a two-dimensional form derived from the JIS D0024 standard.

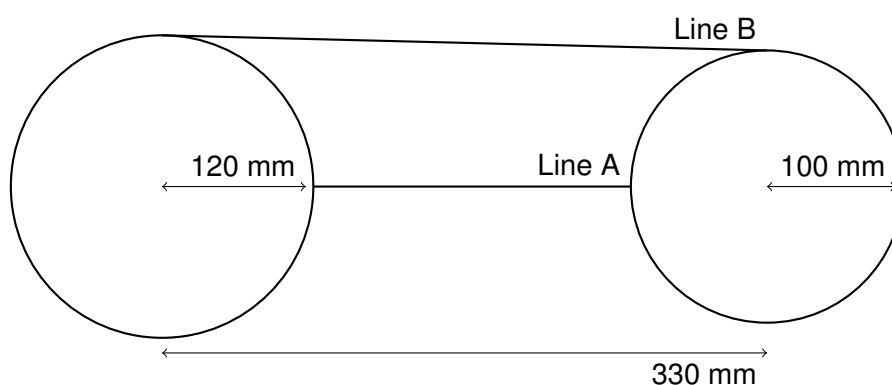


Figure 11: Measurement Template

### Making a Template

- Draw a circle with a radius of 120mm.
- At a point 330mm from the centre of the circle, draw another circle with a radius of 100mm
- Draw a line connecting the centre of the two circles (Line A).
- Draw a tangent to connect the circumferences of two circles (Line B)
- Cut the shape using suitable material
- Attach a plumb line to the measurement point
- The angle is measured between line A and the perpendicular.

### 8.3 ISF Steering Wheel Specifications

To reduce the possibilities of driver injury in the event of collision and to minimise impediments to emergency egress, the steering system must be controlled by a steering wheel which has a continuous perimeter.

A circular shape is preferred, however the upper part above  $\frac{2}{3}$  and/or the lower part below  $\frac{2}{3}$  of the circumference of the steering wheel may be flat as depicted in the diagram below).

permitted

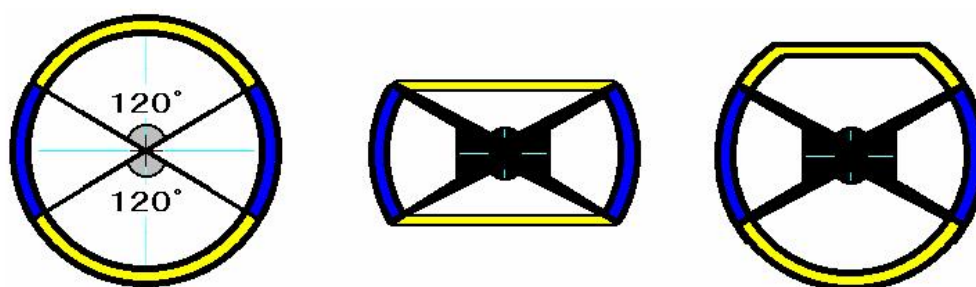


Figure 12: Examples of permitted steering-wheels

not permitted

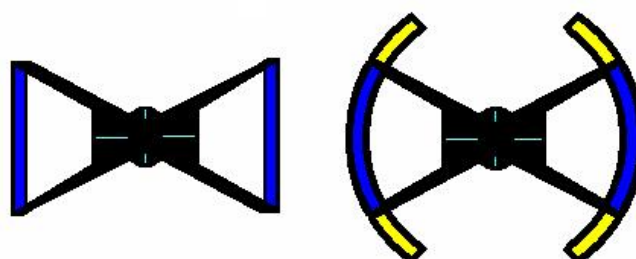


Figure 13: Examples of prohibited steering-wheels

## 8.4 Detailed Scoring

The detailed scoring system (i.e. translation between order of respective ranking and points) will be released in a future version of the regulations. Still, it will be released months before the events, so it will not be of any disadvantage that currently the scheme can not be provided.

## 8.5 Race Commission Application Form

Team:

Subject:

Additional Information:

Time of Submission:

Hand this form to an Official of the European Solar Challenge at the Race Control.

Person handing in this Document:

Signature:

Team Manager:

Signature:

## 8.6 Regularity Test Application Form

Team:

Lap-time target:

First lap number:

Hand this form to an Official of the European Solar Challenge at the Race Control before the first lap has begun.

Person handing in this Document:

Signature:

Team Manager:

Signature:

lap number	lap time	$\Delta t$