INTERNATIONAL

EFFICIENCY CHALLENGE

ELECTRIC VEHICLE

THE SCIENTIFIC AND TECHNOLOGICAL RESEARCH COUNCIL OF TURKEY

INTERNATIONAL EFFICIENCY CHALLENGE

ELECTRIC VEHICLE

Electromobile Hydromobile

RULES

CONTENTS

I. ADMINISTRATIVE AND FINANCIAL RULES

1. Aim and Scope of The Competition

The objectives of "*Efficiency Challenge Electric Vehicle*", organised by TÜBİTAK since 2005, are to contribute to technologic development, create awareness of alternative and clean energy sources, and provide the participants with knowledge and professional and social experience. In this regard, it is necessary to closely follow global technological advancements and changes. When we look at the research and practices all over the world concerning electrical vehicles, we see that battery-fed vehicles are at the forefront and in the near future battery-fed vehicles will become common in our daily lives.

Hydrogen-fuelled vehicles receive their power from a fuel cell system that converts hydrogen stored in the vehicle into energy. With the Hydromobile category, which has been a part of Efficiency Challenge Electric Vehicle since 2007, a community of young engineers and scientists with knowledge and experience to encourage industrial implementation of hydrogen energy and strengthen its potential has been brought together. In the 2014 competition, it was stipulated that the vehicles be domestically produced, focusing the race concept on energy efficiency.

The sportive part of the competition is undertaken in collaboration with the Turkish Automobile Sports Federation (TOSFED). For this reason, participants are required to comply with the sportive racing rules set out by TOSFED.

TÜBİTAK has the right to make changes to **the rules** mentioned in this document as well as to **the weekly schedule.** In case of any ambiguity in the technical rules, the decision of the Jury shall be final.

2. Event Schedule

Activity	Dates
Registration Dates	January 20 – February 28, 2021
Online Training Programme	February, 2021
Submission of Progress Reports	March 8 - 12, 2021
Announcement of the Results of Progress Reports	April 5, 2021
Deadline for Withdrawal from the Competition, Submission of the Request for Team Captain Change, Advisor change (if any) and Member Changes	July 16, 2021
Submission of Technical Design Reports	July 12 - 16, 2021
Announcement of the Results of Technical Design Reports	August 13, 2021
Race Week Records	August 31, 2021
Technical inspections	September 1 - 3, 2021
Electromobile and Hydromobile final race	September 4 - 5, 2021
Award ceremony and closure	September 5, 2021
TEKNOFEST exhibition of vehicles and Award ceremony	September 21 - 26, 2021

3. Application Rules

- In the competition, university undergraduate, graduate, postgraduate and doctorate students can participate as a team. The application should be made by the team captain.
- Applications are submitted online between **January 20, 2021- February 28, 2021** website https://kys.turkiyeteknolojitakimi.org/tr/ The printed documents are not required from teams in the application.
- The team captain registers on the system in between the application dates, records of the team members accurately and completely, and sends an invitation to the members' email addresses for approval. They accept an invitation from the team information section in the https://kys.turkiyeteknolojitakimi.org/tr/ system and their records are completed. Otherwise, the record is not complete.
- At the application date, all team members and the team captain must be students. In the determination of the contrary situation, the said person is eliminated from the competition.
- Teams can have an advisor. Advisor registration, if any, is mandatory.
- Teams should consist of a maximum of twenty (20) persons, including the team captain and advisor (if any). It is mandatory to have a team captain on the team. There may be an "advisor" in the team, but it is not mandatory.
- Team members do not have to be from the same universities. The team may consist of members from different universities. Coordination should be provided by the team captain. The team captain can appoint a member or (him/her)self as the person of contact by selecting the add contact option when adding members.
- Teams are composed of students from different classes, taking into account the increase of scientific and technical achievements, encouragement of teamwork in a coordinated manner, and the sustainability in next years team will be considered.
- The team captain cannot captain more than one team. A student cannot be a member of more than one team. The team captain and members cannot pilot a different team during the competition week. If it is determined otherwise, the team captain or the student is eliminated from the competition.
- All correspondence with the Directorate should be carried out by the team captain.
- The competition is organized in two categories as Electromobile and Hydromobile. A team can apply for only one category. The category cannot be changed.
- A team name may not be used by another team. TÜBİTAK may request the teams that apply with the same team names to change the name of the team that made the application later. Team names are not expected to exceed 20 characters.

- The team captain is responsible for the team members in the competition area and all preparation work including registration.
- A change of team captain cannot be made except for compelling reasons (force majeure).
- **Foreign teams must send their team captain change petition to the challenge@tubitak.gov.tr by e-mail address on the dates specified in the competition calendar. The formats of the team captain change petition is announced at www.teknofest.org.**
- **Foreign teams must submit a copy of their team captain change petitions forms that include a wet signature in the competition area.**
- Before the first incentive for preparation is transferred, the team captain change takes place by the acceptance of the change request e-mail sent through the https://kys.turkiyeteknolojitakimi.org/tr/ system by all members of the team.
- After the transfer of the first incentive amount for project preparation purposes, a petition and submission report should be prepared for the change of team captain due to force majeure until 16.07.2021 and should be signed by the current and the new team captain. A new letter of undertaking should then be signed by the new team captain. All invoices for using the support, if any, and a receipt showing that the remaining amount has been transferred to the new team captain should be delivered to the new team captain. The information and documents submitted in the submission report should be written in detail. The current and new team captain should then send the signed delivery report to the challenge@tubitak.gov.tr email address. The wet signed report, commitment letter and letter of application for the team captain change should all be sent by mail to the TÜBİTAK Etkinlikler Müdürlüğü, Tunus Caddesi No: 80 Kavaklıdere/ANKARA address. The change will be allowed after the approval of the Directorate once all documents have been checked.
- Membership changes in the teams can be made by the team captain until **16.07.2021** on the https://kys.turkiyeteknolojitakimi.org/tr/ system. The change is notified to all members of the team by mail. If the enrolled student is under the age of 18, the consent letter (In accordance with the sample published by TÜBİTAK at www.teknofest.org) signed by the parent/guardian should be sent to the challenge@tubitak.gov.tr e-mail address within five (5) days.
- **Team captain, academic advisor (if any) and member changes cannot be made after July 16, 2021.**
- **Foreign teams can withdraw from the competition until July 16, 2021. They must report their withdrawal with a petition signed by the team captain to challenge@tubitak.gov.tr.**

4. Online Training Programme

Training can be done through training videos prepared due to the COVID 19 Pandemic. Teams are recommended to watch all training videos to increase their success. If the conditions are suitable, piloting training can be given.

5. Reports and Driving Test

5.1. Progress Report

- A report containing summary technical information about the work done or will be done by the teams for the Electric Vehicle. Interior and exterior photographs or technical drawings of the vehicle can be given in the report. The Team Captain is responsible for uploading the report in the desired format.
- The application is uploaded to the https://kys.turkiyeteknolojitakimi.org/tr/ system, in the format specified during the application. The report preparation guide is announced on the www.teknofest.org website.
- Teams that do not upload the report to the application system until the deadline are eliminated from the competition.
- The report is written in 50 pages, Arial and 12 font size, including cover and appendices. The page margins of the report are 2.5 cm (0.984 inches) at quadrants; paragraph spacing is also made in 1.15 units. Pages are used in A4 size and vertically. If the report is more than 10 pages, 2% of the total score is reduced for each page.
- Progress report can be prepared in Turkish or English. It is mandatory to use a single language in all report content.
- 20% of the development report total report score is added over the technical design report score. The team whose progress report is below the lower limit score to be determined is eliminated from the race. Teams with a lower limit score and above for which a Progress Report will be determined will be eligible for First Preparation Support.
- Teams that are successful according to the evaluation are announced on the www.teknofest.org website.
- Objections to the results of the report can be made with a signed petition by the team captain within 5 working days following the related announcements. The scanned version of the petition is sent to challenge@tubitak.gov.tr by e-mail. Objections are evaluated by the Advisory and Assessment Committee and the teams are notified of the results by e-mail. The results cannot be appealed for the second time.
- First preparatory support is given to successful teams.
- Teams that are successful according to the progress report evaluation will be announced on April 5, 2021 on www.teknofest.org.

5.2. Technical Design Report and Driving Test Video

- Technical Design Report is the report in which the development process of the vehicle, the final technical and mechanical design and the features of the produced domestic parts are explained in detail with photographs or technical drawings.
- The technical design report should be uploaded on the https://kys.turkiyeteknolojitakimi.org/tr/ system between the dates announced on the www.teknofest.org website. The report preparation guide is announced on www.teknofest.org.
- In the Technical Design Report, the team explains in detail how it used the First Preparation Support, what materials it purchased, and the material photos.
- The report is written in 150 pages, Arial and 12 font size, including cover and appendices. The page margins of the report are 2.5 cm (0.984 inches) at quadrants; paragraph spacing is also made in 1.15 units. Pages are used in A4 size and vertically. If the report is more than 10 pages, 2% of the total score is reduced for each page.
- A drawing in A4 size (21 x 29.7 cm) showing all power circuits of the electrical equipment of the vehicle must be given in the technical design report. Drawing; Includes batteries, fuses, circuit breakers, power control switches, capacitors, motor control circuits (drivers), motor or motors, charging unit and connection cables.
- Teams that get below the lower limit score determined from the technical design report are eliminated from the race.
- Dynamic Driving Test Video is a video that includes making the infinite mark around two poles spaced 8 meters apart from a flat area of 50 square meters with a maximum of two forward and one maneuvers to dynamically measure the movement and maneuverability of the vehicle and bring the vehicle to the starting point. Security measures are under the responsibility of the Team Captain during video shooting.
- Dynamic Driving Test Video, maximum two (2) minutes and 60 mb in mp4 format. The viewing angles and quality of the vehicle are important in evaluation. In the first 5-10 seconds of the video, the team captain or driver who will drive the vehicle promotes with his / her name and team name.
- The Technical Design Report and Dynamic Driving Test Video are uploaded to the http://www.kys.t3vakfi.org system between 12 - 16 July 2021. The team that does not upload the report and video link to the system is eliminated from the race. A screenshot of the report and video uploaded is sent to the e-mail addresses of the Team Captain and all members.
- The Technical Design Report can be prepared in Turkish or English. It is mandatory to use a single language in all report content.
- Team Captain is responsible for uploading the report and video in the desired format.
- The Technical Design Report and Dynamic Driving Test Video are evaluated

together according to the scientific criteria specified by the expert juries. The score of the team is determined by adding the points of all juries. Teams that get below the lower limit score determined by DDK according to the report and video evaluation are eliminated from the race. First Financial Support transferred to the team can be recalled by DDK.

- Technical Design Report is taken into consideration in the Design and Domestic Product Awards evaluation. Teams with similar technical design reports are not awarded the Design Award and the Domestic Product Award.
- Teams that are successful according to the Technical Design Report and Dynamic Driving Test Video evaluation are announced on 13 August 2021 at www.teknofest.org.

6. Financial Supports

6.1. First Financial Support for Preparation

- This support is given to each successful team as a result of the evaluation of the progress report. The amount of 15,000 TL is transferred to the team's captain to improve their vehicle.

- To receive payment of the support, the teams, eligible as per the results of the evaluation of the progress report, should accept all responsibilities and rules of the competition by uploading the duly signed Letter of Commitment to https://kys.turkiyeteknolojitakimi.org/tr/ on the dates specified in the competition calendar. This Letter of Commitment must be wet-signed by the team's captain. The use of the incentive is depended upon the Letter of Commitment.

- All the team members (within the teams entitled to receive the incentive), who are younger than 18 (born after 11 April 2003) on 12 April 2021 (the last day of submitting the Letter Commitment) must upload the duly signed Letter of Consent to https://kys.turkiyeteknolojitakimi.org/tr/ on the dates specified in the competition calendar. This Letter of Consent must be wet-signed by the parent/guardian of the team member, younger than 18.

- The formats of the Letter of Commitment and the Letter of Consent are announced at www.teknofest.org.

- The wet-signed Letter of Commitment and all the wet-signed Letters of Consent are sent to the address "TÜBİTAK Etkinlikler Müdürlüğü, Tunus Caddesi No: 80 Bakanlıklar/ANKARA". The payment of incentive is not made to the teams with incomplete, incorrect documents or incomplete signatures on their documents.

6.2. Second Financial Support for Preparation

- The teams that are eligible to participate in the competition as a result of the evaluation of the technical design report and flight video will receive an amount of 10,000 TL incentive. The incentive is transferred to the IBAN account of the team's captain, registered in the application system. The responsibility of correctly spending the incentive for the purpose is vested upon the team's captain.

6.3. Collaboration Supports

- Teams can collaborate with the public institutions and private organizations before and during the competition week to increase their opportunities for success. Within the scope of these collaborations, it is obligatory to employ the TÜBİTAK logo on the materials, used by the relevant team in the competition site/area. The visibility and size of the TÜBİTAK logo must not be less and smaller than the logo of the sponsoring institution/organization.

7. Race Week

- All teams shall be registered by the team captain on first day of the race. Other days team's shall not be registered.

- Official IDs of all team members must be submitted in the registration.

- When the registration process is completed, all teams are given a 15-minute appointment time for the first technical control by lot. It is the team's responsibility to follow the appointment time and to have the vehicle ready. The team that does not enter control in the first 5 minutes of the appointment time, loses its right and is discharged from the technical control right.

- The Team Captain is responsible for the management of the team tents, the works done and all the materials delivered to the tent.

- Production, repairs, etc. that are not suitable for health and work safety are not allowed in the racing area.

- In order for the vehicles to enter technical control, they must first complete the back and forth maneuvers shown in Figure 19 on the 50 square meter track at the "dynamic driving test" within 120 seconds. For the dynamic driving test, teams shall line up at 16:00 on Thursday, September 2, 2021 at the latest.

- Teams that pass the test successfully will be taken to the technical control garage last on 3 September 2021 at 15:00. Teams that cannot pass the dynamic driving control cannot enter technical control.

- For the second and other technical controls, teams shall make an appointment at the registration desk.

- Maximum 5 people from each team are taken into the garage at the same time with the vehicle taken to the garage for technical control. Team members taken into the garage only answer the questions of the juries. No technical work is allowed in the garage. In case of detection, the technical control is terminated, the team is asked to make an appointment again.

- Teams may not let people who are not members into the racing area or technical control garage. On detection, the team is penalized by 5 Wh. Individuals are banned from racing for three years.

- The teams bring a copy of the technical design report (in electronic or printed form) to the technical control garage. Technical Control is made by considering the Technical Design Report. Team members who entered the garage that do not bring the Technical Design Report are asked to respond to detailed information.

- On the first day of the technical inspections, 6 Wh is reduced from the total end-of-race energy consumption of the teams that receive a "sticker" in the first technical inspection after the dynamic driving test. 3 Wh is deducted from the energy consumption of the team that lacks at most two items among the items in the "checklist" in the first technical control and succeeds at least in the second technical check to be carried out on the second day of the technical controls. Teams who subsequently enter technical controls to complete their deficiencies add 1.5 Wh to their total end-of-race energy consumption at each of the technical checks after the third technical control.

- During technical controls, a Checklist is given to the teams so that they can follow their shortcomings. During the Technical Controls, the deficiencies of the team in the checklist are primarily examined.

- Teams that are successful in technical controls and certain parts of the vehicle are given stickers. It is forbidden to remove stickers or replace sticker parts before the actual race.

- Vehicles that get stickers can go on a training tour at the appropriate times on the main track. In order to evaluate the team's own performance, energy consumption devices can be given to the team for training tours, if desired. However, the measurements made are not taken into account in the race evaluation.

- In the common areas where the team paddock is located, vehicles are moved without starting the motor for safety. In case of detection of the contrary, teams are penalized with 1 Wh.

- During the race week, the teams or team members who are found to violate the administrative, sportsmanship and ethical rules of the race may be penalized by DDK as penalties / ban from the race etc.

- The teams that are determined to not comply with the safety and driving rules defined by DDK and TOSFED, neglect to take the necessary precautions in a way that endangers the safety of the race or who are determined not to take the necessary precautions deliberately may be sanctioned by the DDK such as warn, void the First Final Race score or eliminate them from the races.

- The vehicles shall be designed to be able to enter technical control and racing in weather conditions such as light rain and fog. Unless otherwise declared by TÜBİTAK, vehicles with an appointment in weather conditions such as light rain and fog will enter technical control. The appointment right of the team that does not enter the technical control in the first 5 minutes of the appointment time will be deemed unsuccessful and will be deducted from the right of appointment.

- If necessary, DDK can carry out unannounced technical controls on the vehicles at any time during the race week to avoid any risk to the race and driver safety.

- DDK can update calculation formulas according to the characteristics of the track.

- During the race week, the teams have the right to submit a maximum of 5 petitions for objection signed by the team captain. A second petition on the same subject is not accepted. The petition right of the team is deducted. The petitions are evaluated and decided at the DDK meeting. The decisions are reported to the teams. DDK decisions are final.

- With the completion of the technical controls, the list of teams to participate in the race is determined on Friday, September 3, 2021 at 18:00.

- Final Races can be held twice within the scope of the rules stated under the heading "17. ELECTROMOBILE AND HYDROMOBILE RACES". The 1st Final Race for both categories will be held on Saturday, September 5, 2021, and the 2nd Final Race on Sunday, September 6, 2021.

- In the 1st Final Race, the order of placing the vehicles on the track is determined by lot, and the order of the 2nd Final Race is determined according to the result of the 1st Final Race. In the 1st Final Race, scores are sorted starting from the highest and backwards from the front of the track. Teams not participating in the First Race will participate in the 2nd Race, in alphabetical order, behind the first race cars.

- Teams have the right not to participate in one of the final races. Nonattendance or inability to complete one of the Final Races will not affect the result of the

other final race. The current race score is taken into consideration. The best race score achieved by the teams participating in both Final Race is taken into consideration. Teams that do not participate in both Final Races or cannot complete both races will not be considered.

- If the number of vehicles to participate in the race is high, both final races can be held in two groups.
- In the final races, all teams start racing at the same time and complete the race within the specified time for the category in which the vehicle is racing. It is the team's responsibility to follow the lap and time of the vehicle in the race.
- In accordance with the sportive racing rules, a team that participated in the race must have finished the race in the pit area within the given time to be considered as finished. For example, the team that took one lap and entered the pit is considered to have finished the race, while the vehicle that break down on the 10th lap and remains on the road is not considered to have finished the race.
- After the race, all teams are taken to the technical control area for technical checks and braking test.
- Post-race vehicles are registered with the Team Captain's institution inventory for development in the coming years.

8. Awards

Performance First Award (Electromobile, Hydromobile)	**50.000 TL**
Performance Second Award (Electromobile, Hydromobile)	**40.000 TL**
Performance Third Award (Electromobile, Hydromobile)	**30.000 TL**
Efficiency Record Award	**25.000 TL**
Technical Design Award	**25.000 TL**
Visual Design Award	**15.000 TL**
Committee Special Award	**15.000 TL**
First Domestic Product Incentive Award	**20.000 TL**
Second Domestic Product Incentive Award	**18.000 TL**
Third Domestic Product Incentive Award	**16.000 TL**
Promotion and Dissemination Incentive Award	**3.000 TL**

8.1. Performance Awards

- Performance awards will be given to the winning teams in the final races held within the framework of the rules specified under the heading "17. ELECTROMOBILE AND HYDROMOBILE RACE". In order for a team to receive a performance award, the final score of the race must be at least 300 according to the formula stated in the "17. ELECTROMOBILE AND HYDROMOBILE RACING" title. If the characteristics of the race track change, the score limit can be updated.

8.2. Efficiency Record Award

- Productivity Record Award will be given to one of the teams that completed the race by completing 7 laps in the electromobile category has an energy consumption value of less than the official lowest energy measurement value of the last 5 years race organization "631 Wh" (23,83 Wh per tour for 2 km of Körfez Race Track). For this award, the consumption value read from the energy meter device will be taken into consideration, without penalty points being processed. If there is more than one team breaking the record, this award will be given to the team with the lowest energy consumption value. If the characteristics of the racetrack change, an update will be made so that the record value will be offset on the basis of km.

8.3. Design Awards

8.3.1. Technical Design Award

- It is an award to be given to the team that has found the product superior and innovative in terms of mechanical and electronic design, engineering work and domesticity of the vehicle. The technical design report submitted by the teams and the examinations made during the race week will be taken into consideration in the award evaluation. The teams are required to describe their work on the mechanical design of the vehicle (eg. door lock mechanism, carbon rim, suspension system, steering and turning system mechanism, aerodynamic shell design) in the report. If the systems applied on the vehicle have the reasons for their application, their numerical advantages over other systems and the details of their calculations, their potential to receive technical design awards from mechanical details will increase.

- Only one Technical Design Award can be given for all Electromobile and Hydromobile categories. If more than one team is awarded, the amount of the prize will be shared equally among the teams.

- This award is given to teams that receive sticker and go to the racetrack.

8.3.2. Visual Design Award

- The Visual Design Award is given to the team that is unique and aesthetic in terms of vehicle interior and exterior appearance (shell, console, cockpit, etc.), industrial production, and / or considered suitable for daily use. In the award evaluation, the technical design report submitted by the teams and the examinations made during the race week will be taken into consideration.

- Only one Visual Design Award can be given for all Electromobile and Hydromobile categories. If more than one team is awarded, the amount of the prize will be shared equally among the teams.

- This award is given to teams that receive sticker and go to the racetrack.

8.4. Committee Special Award

- It is a prize to be given to a team or vehicle that brings innovation other than performance or design, contributes to the spirit of the activity, etc. Observations made by the Advisory and Evaluation Board (DDK) and TÜBİTAK officials during the race week will be taken into consideration for the award evaluation.

- Only one Cpmmittee Special Award can be given for all Electromobile and Hydromobile categories. If more than one team is awarded, the amount of the prize will be shared equally among the teams.

- This award is given to teams that receive sticker and go to the racetrack.

8.5. Promotion and Dissemination Incentive Awards

- These awards are given to the teams that create awareness in the society about racing and show outstanding activities for its popularization. All kinds of press, communication, promotional activities, workshops targeting various segments of the society, seminars, congresses / conferences, etc. related to races and vehicles regarding alternative energies and technologies and the widespread impact of the mass reached in the national or international arena within the scope of these activities are evaluated.

- The reports prepared according to the report format and evaluation criteria for the award application are uploaded to the http://www.kys.t3vakfi.org system between 2 - 6 August 2021. The reports are evaluated according to scientific criteria by expert juries and successful teams are determined.

- The updated IBAN information of all the members of all teams, including the

Team Captain, of all awarded teams in the race area, will be sent to challenge@tubitak.gov.tr within ten (10) working days. Award amounts are transferred equally to the accounts of Team Captain and member students. The reward amount will not be transferred to incomplete, incorrect or someone else's accounts.

8.6. Domestic Product Incentive Award

- These awards will be given to the teams that have superior domestic design and production in terms of the product produced. Teams to be awarded must score at least 1,000 points from the technical design report and meet one of the following criteria:

i. Domestic production of four compulsory local parts specified in the "II TECHNICAL RULES – 1.a Locality" title

ii. Domestic production of three compulsory local parts specified in the heading "II. TECHNICAL RULES - 1.a Locality" and at least two optional local parts.

In case of more than 3 teams that meet the criteria, the top 3 Turkey and North Cyprus Turkish Republic teams as a result of scoring based on the technical design report and technical evaluations at the vehicle will be awarded in the amount specified according to the score order. While making this ranking, no distinction will be made for Electromobile and Hydromobile categories.

8.7. Transferring of the Awards

- International Bank Account Number (IBAN) information of all team members awarded in the competition must be sent by e-mail to challenge@tubitak.gov.tr by the team captain within ten (10) working days. Rewards are transferred equally to these IBAN numbers. No reward transfer is made to incomplete, incorrect or someone else's IBAN numbers.
- **If foreign teams receive any awards, the amount of the prize is paid in cash in the competition area.**

9. Procedure and Principles of the Expenditure and Refund Conditions

- Teams form a purchasing team with the participation of at least 3 team members, including the team captain, for all kinds of purchases to develop their vehicles.
- All documented expenditures (including those made by credit card) made by team members for preparation or participation in the competition with the approval of the purchasing team during the year of the competition are paid

from the vehicle development support. Undocumented expenditures are not accepted.

- Teams create a list of "item ", "invoice date", "company name" and "amount" for all the expenditures they make to manufacture their vehicles. Below the list, "Market price research has been carried out and the specified items have been accepted after inspection." is added and the list is signed by the purchasing team.
- In the invoice or other expenditure documents, the Team Name and the expressions "17th International Efficiency Challenge Electric Vehicle" should also be included. If these statements are not included in these documents, they must be attached to the document and signed by the Team Captain.
- Electronic invoice printouts are accepted for purchases abroad. The Turkish Lira (TL) equivalent of the payments is taken as the basis.
- The following payments are made by the Team Captain, provided that the transferred support amount is not exceeded. Taxes arising from wage payments are covered by TÜBİTAK. For manual payments to team members, a pay list must be prepared by the team captain and signed by the members. Members are required to obtain a receipt for payments transferred to their bank accounts.
    - During the competition week, transportation fees can be paid for each team member from the vehicle development support by calculating the distance between the location and the city center where the competition will take place. Within the scope of this payment, 65 Kurus per km, maximum of 780 TL per person can be paid. Each team member can use the fee given to him for bus, plane, private vehicle, city taxi, food, etc.
    - In case the accommodation is not covered by TÜBİTAK or TEKNOFEST organization, a separate fee may be paid to team members not exceeding 102 TL per day, in addition to the upper limit of 780 TL per person, by obtaining the approval of the TÜBİTAK Events Division.
- In case of purchasing durable goods or fixed assets (materials with code 253-255: 3D printer, device, etc.), this equipment will be donated to the team captain's school at the end of the event. At the relevant school, this equipment is recorded in the inventory tracking list and a copy of the asset transaction receipt is scanned together with the invoices and uploaded to https://bilimtoplum-pbs.tubitak.gov.tr.
- No expense can be made on the purchasing of products or materials after the date of the competition. The unused funding for vehicle development must be returned to the IBAN account of “TÜBİTAK Ankara Kamu Kurumsal Şube TR15 0001 0017 4506 0280 7250 33” by indicating the competition name and team name. The transaction receipt is uploaded to https://bilimtoplum-pbs.tubitak.gov.tr.
- Until 01 November 2021, invoices of all products and materials, material list signed by the purchasing team, payment list or bank receipt if payment has been made to team members by hand if any, a copy of the asset transaction receipt, bank receipt indicating that the remaining amount of the development

support has been refunded to TÜBİTAK bank accounts should be uploaded to https://bilimtoplum-pbs.tubitak.gov.tr.

- The team captain is obliged to keep the original documents for ten (10) years.
- TÜBİTAK may request the related amount back from the team captain who does not upload the required documents to the system until 01 November 2021, does not keep the documents, spend more than the support amount or spend out-of-scope, by adding default interests according to Article 51 of the Law No. 6183 on the Procedure for the Collection of Public Receivables.
- If a team whose application has been accepted does not participate in the competition by notifying TÜBİTAK in writing, all support provided to the team must be returned to TÜBİTAK's account number TR15 0001 0017 4506 0280 7250 33 (TL) until 01.11.2021, regardless of the expenditures. Otherwise, entire support provided starting from 01.11.2021 will be collected together with the default interest based on Article 51 of Law No. 6183 on the Procedure for the Collection of Public Receivables.

The Advisory and Assessment Committee has the right to reclaim all vehicle development support regardless of the expenses incurred in the following cases:

I. Withdrawal of the team with written notification after the deadline for technical design report submission,

II. Teams do not send the technical design report by the specified date and do not provide notification in writing that they have withdrawn,

III. Team’s technical design report and driving test video are not sufficient,

IV. Deciding that the given support was not used in the manufacturing process of the vehicle,

V. Failure of the team to register in the event area and/or in the competition area for technical inspection,

VI. Ethical violations in the reports (for example, quoting from another team's report or the reports are the same / very similar),

VII. Failure to participate in the award ceremony program in the city if the team receives an award,

VIII. Expulsion from the event by the Advisory and Assessment Committee due to ethical violations, technical inadequacy, and/or unsportsmanlike behavior.

With the Advisory and Assessment Committee decision, the preparatory supports (vehicle development support) may not be requested in the following cases:

I. Proving with reports and visuals that a team whose Technical Design Report or Driving Test Video is not accepted / not found sufficient / receiving insufficient score has spent the provided support to produce the vehicle.

10. Other Provisions

- During the competition, all participants must follow the announcements made on the http://www.teknofest.org website and sent to their registered e-mail addresses at https://kys.turkiyeteknolojitakimi.org/tr/
- If deemed necessary by TÜBİTAK, changes in the rules booklet can be made until the application deadline. The most recently announced updated rules booklet is valid in the competition.
- In the event of a disagreement concerning the technical rules, the decision of the Advisory and Assessment Committee will be valid. In cases where there is no provision in the rules booklet, the decision of the TÜBİTAK Events Division will be applied.

II. TECHNICAL RULES

1. Being Domestic

a) Electromobile and Hydromobile teams must have designed and produced four vehicle subcomponents that are mandatory, which are stated below, themselves in accordance with the criteria specified in technical design report.

Mandatory sub-parts for Electromobile:

i. Motor
ii. Motor drive
iii. Battery management system (BYS)
iv. Built-in charge unit

Mandatory sub-parts for Hydromobile:

i. Motor
ii. Motor drive
iii. Battery management system (BMS)
iv. Energy management system (EMS)

b) Teams that cannot make the parts specified in **II.1.a** can participate in the race for **10 Wh** penalty points for each missing piece. However, in order for a team to complete the technical controls and participate in the race, it must make **at least one of the mandatory sub-parts** locally (see ANNEX 2: PENALTY LIST).

c) It is recommended that the teams targeting the Domestic Product Incentive Award and the Technical Design Award should also make the following sub-parts locally. 2 Wh award points will be given for each local sub-part.

Optional sub-parts:

i. Battery packaging (Electromobile and Hydromobile)
ii. Electronic differential application (Electromobile and Hydromobile)
iii. Vehicle control system (VCS) (Electromobile and Hydromobile)
iv. Fuel cell (Hydromobile)
v. Fuel cell control system (circuit) (Hydromobile)
vi. Insulation monitoring device (Electromobile and Hydromobile)
vii. Steering system (Electromobile and Hydromobile)
viii. Door mechanism (Electromobile and Hydromobile)

d) In technical controls, it will be checked whether the parts declared to be domestic in the technical design report meet the localization requirement. Reporting and production of domestic parts are expected to be team specific. **In the event that even a single piece is shared among the teams or if a similar report is submitted to a large extent, the local status of the parts is not accepted and the teams are expelled from the races.**

e) The **design** of the domestic parts must have been originally made by the team. Even if the production works of the designs belonging to ready-made products are made by the team, they will not be considered domestic.

f) In order for a team to use the domestic part made in the previous year, the comparison table requested in the technical design report must be presented in detail.

g) A vehicle part that has been accepted as domestic in past races will not be considered as domestic unless it meets the necessary conditions specified in this document. **The students who take part in the team** are responsible for the domestic design, production, reporting and making the necessary explanations in technical controls.

2. Drive System and Electrical Hardware

a) In the Electromobile category, a group of batteries is used as the main (and only) energy source in the vehicles. No second type of energy supply (supercapacitor, fuel cells, etc.) shall be used in the vehicles. No such equipment as capacitors, fuel cells, etc. shall be used in the motor driving system (between the battery output and motor) with capacities that exceed the intended purpose for the aim of storing energy. The energy capacity of the energy storage elements in the motor driving system (passive components used

for filtering purposes) is limited to a maximum of 1000 J (to be calculated from the label value of the capacitor).

b) For the Hydromobile category, the total of the label values of output power for nominal fuel cells (which could be multiple) to be used in vehicles may be a maximum of 3 kW and a minimum of 300 W. The output power of fuel cell modules may change in positive or negative directions depending on the type of reactant gasses fed inside (for example, using O_2 instead of air) and gas feeding conditions (temperature, humidity, pressure values, etc.). For this reason, only the label values of power modules will be taken into account (the teams are requested to certify these label values) and inspections will be based on this value. While the operating conditions of fuel cell modules may be different for each team to the extent to which they comply with safety precautions, the output performance of the modules could be increased provided that suitable safety measures are taken. In the event that the fuel cell is fed with oxygen, oxygen and hydrogen lines should be located with a minimum distance of 10 cm between them. Fuel cell anode and cathode outputs must be independent of each other, and they must be released into the atmosphere from the back of the vehicle by two separate evacuation lines.

c) In the Hydromobile category, a supercapacitor may be used in vehicles provided that its specifications are indicated in the design report. The supercapacitor to be used should be connected to the system through a converter. **Circuits and equipment such as contactors, relays, or static switches that only turn on and turn off will not be accepted as converters.** If used, the supercapacitor is limited to a maximum of **110 kJ** (to be calculated based on the label value of the capacitor). The energy difference will be calculated by measuring the supercapacitor voltage before and after the race. In order to measure supercapacitor voltage, the capacitor terminals should be accessible. Use of a supercapacitor for Hydromobile vehicles and energy measurement are shown in Figure 17. Only electric motor types may be used in vehicles that will participate in the competition.

d) Only electric motor types may be used in all vehicles participating in the race.

3. Motor

a) Teams that perform motor design and production domestically are responsible for the following items during technical controls:

i. Awareness of general electric machine theory and construction
ii. Awareness of electrical and mechanical properties
iii. Giving information about magnetic and thermal analysis
iv. Giving information on production stages with visuals such as photos and videos
v. Providing information about test method and results

b) It will be checked in the technical design report and the team makes technical controls that the requested analyzes. Thermal, magnetic and electrical analyzes of ready-made products (core, winding, etc.) provided by the manufacturer constitute an obstacle to the acceptance of the motor as a domestic product. The team should do all design and optimization stages of the motor, and the simulation results should be presented in stages in the technical design report and technical controls.

c) In order for the locality of the electric motor to be accepted, it must pass the dynamic driving test while on the vehicle.

d) In order for the motor to be considered as a domestic part, the program raw files showing the design and simulation results of the motor must be sent together with the technical design report. During technical controls, the Advisory and Evaluation Board may request these files to be run and shown.

4. Motor Driver

a) Teams that perform the design and production of motor drivers domestically are responsible for the following items during technical controls:

i. Giving information about electrical circuit design

ii. Giving information about simulation study and control algorithm

iii. Providing information about printed circuit board design

iv. Giving information on production stages with visuals such as photos and videos

v. Providing information about test method and results

b) All design and optimization stages of the motor driver and simulation results should be presented in stages in the technical design report and technical controls. The motor driver circuit must be boxed and fixed in the vehicle. Boxing of motor driver circuit is mandatory. Participation in the race with an unboxed motor driver will not be allowed. The box will protect the motor driver circuit from water, oil, dust, etc. It must be designed to protect against factors. During the technical control, the Advisory and Evaluation Board may be asked to disassemble the motor driver from its fixed location and show the motor driver circuit for detailed examination. With motor driver, motor, battery, etc., plug connectors should be preferred for connections between other outdoor units.

c) In order for the motor driver to be accepted as a domestic part, the program soft files showing the design and simulation results must be sent together with the technical design report. During technical controls, the Advisory and Evaluation Board may request these files to be run and shown. In technical controls, each team will be given a maximum of 10 minutes for the motor driver to evaluate the local parts.

d) In order for the motor driver to be accepted, the motor driver must pass the dynamic driving test while being on the vehicle.

5. Battery

Battery; It generally consists of a battery protection container and one or more battery packs formed by battery cells.
Battery Cell: A single cell with lithium-based plus and minus terminals.
Battery Pack: It is the group that includes multiple battery cells combined in series, parallel, series-parallel or parallel-series and includes temperature sensors.

a) Nowadays, considering that lithium-based battery technologies are used in electric vehicles, so only Lithium-based batteries will be allowed to be used in races.

b) The battery should be placed inside the vehicle and protected from short circuit and leakage by a protection container.

c) The battery should be easily accessible from outside the vehicle without removing any component of the vehicle (hood, motor, seat, BMS, etc.).

d) The protection container should be fixed strongly at the bottom of the vehicle by means of nuts and bolts of grade 8.8 and a minimum diameter of 8 mm. The fixing process must be done in such a manner that the fixing apparatus and fixing points will not move out of position even in the event of an accident.

e) The battery should have a fuse for high current and short circuit protection, and a manual breaker to ensure safety in cases where interference to the battery is required (e.g. service disconnect).

5.1. Battery Management System (BMS)

a) The BMS is an electronic system that enables the rechargeable battery cells and packages to operate within safe operating limits, and its use is mandatory. For this purpose, the BMS should monitor the voltage, current, temperature (the hottest cell in the package), state of charge (SOC) of each battery cell and package, and take the necessary safety measures when safe operating limits are exceeded. The voltage of each battery cell, temperature of each package,

and the SOC must be shown on a computer via telemetry. A **passive or active balancing system** should be used to eliminate voltage imbalances that may occur in battery cells.

i. The battery voltage, the highest temperature of the battery packs, and the SOC value should be clearly, accurately and consistently monitored on the display in the driver's cockpit. How the SOC and the highest temperature value is determined should be given in detail in the technical report.

ii. The temperature indicator should be electrically connected to a warning flasher. The flasher should give an audible warning when the battery temperature reaches the critical temperature value. The audible warning should be heard at 80 dB from a distance of 2 m. At the same time, the electrical connection of the battery pack to the system should be broken by an automatic protection system. A range must be provided between the activation temperature of the audible warning system and the system shutdown temperature to allow testing. However, due to the position of the temperature sensor in the battery pack or the battery packaging technique, these values may vary within a temperature range of 15 °C.

iii. It is required that the cells be integrated (series, parallel, series-parallel or parallel-series) in groups (4 or 5, etc.) and each group should be separated from the others by an inflammable material *(See Figure 8).*

b) Teams that develop the BMS domestically shall be responsible for the following items during technical inspections:

i. Demonstrating the BMS physically (the BMS should be easily accessible from outside the vehicle),

ii. Providing necessary information and block diagrams about the BMS design and operating principles (Circuit diagram, PCB drawings, simulation, etc.),

iii. Providing information about the balancing method used in the system and its implementation,

iv. Providing algorithms used to perform measurements and estimates, such as each battery cell voltage, temperature of each pack, detection of the package with the highest temperature and state of charge.

c) In technical inspections, the passive or active balancing system, safety measures described above, and whether the flasher is functional or not will be checked.

5.2. Battery Packaging

a) The battery's protective housing has to be completely encircle the batteries (to prevent short circuit of conducting parts as well as battery terminals) and be made of a material that is resistant to mechanical impacts and fire (protective vessels manufactured from wood, plexiglas, polystyrene, and inflammable plastic are not acceptable) and that prevents leakage of battery liquid *(See Figure 8).* The team that owns the vehicle is obliged to prove that the battery fixing mechanism and battery compartments are strong enough to resist the stresses defined for the roll bars by a test result or an analysis data.

i. In order to cool the batteries, an air or water cooled system should be designed, and if an air cooled system is to be used, the outlet of the ventilation duct should be outside of the vehicle.

ii. The cooling air or water system valves, fans or pumps should be activated with the increase of battery temperature and keep it at the temperature limits that the battery can perform efficiently.

iii. "**High Voltage**" warning signs should be visible on each battery pack.

iv. Location of the battery pack should be demonstrated on the shell of the vehicle with a visible "**High Voltage**" sign.

v. The control measures given below should be implemented in the event of a fire hazard in the vehicles.

- Short circuit protection must be exist for the pack and cells. If possible, cells with these protections (CID, PTC) should be preferred.
- High (overcharged) and low (over discharge) voltage protections must be provided.
- There must be temperature protection. The cooling system should be designed to shut down the entire system when the critical temperature is exceeded.
- During the module design, heat distribution between the cells should be considered.
- The mechanical deformation should be attention in cells, modules and packages.

vi. A physical separation must be placed between the battery pack and the BMS.

b) The cells inside the battery pack should not be simply connected to each other by a cable. For the connecting of the cells, bus bars or special connecting apparatuses should be used. Thus, welding (laser, ultrasound, direct, etc.), soldering, or screwed systems can be used for connecting the cells to each

other. The cells should be fixed to the battery housing. Inflammable materials such as silicone or polyurethane foam should not be used for fixing.

c) The battery housing, battery, and BMS should be accessible with ease from the outside of the vehicle. Connection and fixing equipment must definitely be in accordance with the previous definitions and suitable for an external measurement.

d) During the technical inspections, the data sheets of the batteries, the protective housing, and safety measures will be checked. It will not be allowed to participate to the challenge with inappropriate battery and battery components, including those with problems in terms of location and those that cannot be accessed from the outside.

e) In order for the battery pack to be accepted as a domestic product, the following points need to be detailed in the technical design report as well as explained during the technical inspections:

i. Cell type (pouch, cylindrical, prismatic, etc.), electrochemical data sheets (charge-discharge characteristics of the cells, nominal voltage of the cells, energy density of the cells, etc.),

ii. Battery case material and mechanical (tensile strength, impact resistance), thermal (melting point), and electrical (dielectric constant) properties of the material,

iii. Placement of the battery cells and temperature sensors in the battery pack

iv. The method of fixing the cells in the battery case,

v. Thermal and mechanical properties of each component (including the battery shell) used in the battery case,

vi. Thermal analysis of the battery pack,

vii. Battery cooling system (air, water, etc.) details,

viii. The placement and fixing details of the battery pack inside the vehicle,

ix. If the battery case is designed with an electrically conductive material (carbon fiber, stainless steel, etc.), the inner surface of the battery case must be isolated with an insulating and inflammable material (inflammable PVC-inflammable paper, etc.).

Moreover, the details of the design should be supported by photographs in the technical design report.

5.3. Embedded Recharging Unit

a) This is a switched power supply that is fixed on the vehicle and can charge the battery group by being fed from the grid. It is not obligatory to use this unit; however, it is recommended since it will avoid such risky processes as detaching and reattaching the battery box for charging and it could be easily recharged anywhere. For this purpose, a ready-made power supply could be used. However, it should be designed and manufactured by the team in order to meet domestic design criteria. Since this power supply will manage the recharging process of the battery group together with the control unit, it could be considered a part of the BMS. The specifications of this unit are listed below.

i. It should have a minimum power level of 500 W in order to recharge the battery group in an acceptable time.

ii. It should be able to recharge the battery group over a single-phase grid. Three phase sources could be used; nonetheless, a single separate phase input should be provided.

iii. Active or passive power factor correction feature is not obligatory but is recommended.

iv. Besides full-bridge or half-bridge converter, other switching converter topologies can also be used. It is necessary to provide electrical insulation of the power supply between the grid and the battery group.

v. A transformer operated at grid frequency (50/60 Hz) cannot be used as the main power transformer inside a switching power supply. These kinds of power supplies will not be accepted as switching converters. Similarly, if a grid frequency operating transformer is used as electrical insulation between the grid and the vehicle, that power supply will not be regarded as a switched power supply. Chopping grid voltage by thyristor or triac will also not be considered as switched power supply. These kinds of on-board power supplies that contain a grid frequency operating transformer can be used to charge batteries and partial report points will be given, but they will not be regarded as domestic components.

vi. For electrical safety, a converter that rectifies the grid and decreases the voltage by a buck converter and charges the battery will not be permitted since galvanic electrical insulation between the grid and the vehicle is not provided.

vii. An embedded recharging unit must be on the vehicle during the races.

b) The recharging unit will be inspected in technical inspections by measuring the current and voltage values from the output ends.

6. Technical Drawings

a) In the technical design report it is necessary to provide a drawing of A4 size that demonstrates all power circuits of the electrical hardware of the vehicle (21 × 29.7 cm). The drawing should include the battery, fuse, circuit breakers, power adjustment buttons, capacitors, motor control circuits (drivers), motor or motors, recharging unit, and connection cables.

b) In a second drawing that shows the vehicle from above, the places of these components in the vehicle should be clearly indicated.

7. Electrical Safety

a) All vehicles are required to comply with rules established by national authorities in relation to standardisation and use of low-voltage electric equipment.

b) The power circuit and electrical hardware must power all parts used for moving the vehicle.

c) The auxiliary circuit (network) must power the parts of the electrical hardware used for signalling, lighting, and communication.

d) Although it is required to provide minimum IP 44 type protection for all parts of the electric hardware (for safety against dust and water spillage), IP 55 type protection is recommended.

e) All types of electric connections between the energy-consuming units and the energy-producing hardware shall be the non-sparking type and should be cut by 2 circuit breakers, one inside and one outside the vehicle (emergency breaker switch with top-pressing/emergency stop) *(See Figure 9).* The characteristics of the circuit breakers are given below.

i. The internal switch should be placed in such a way that the driver can easily see and reach it from outside when required.

ii. The button of the general circuit breaker in closed vehicles, on the outside of the vehicle, should be placed on the left side of the driver in the driving direction under the cockpit window.

iii. Both general circuit breakers should comprise a red button together with a yellow circle with a minimum diameter of 8 cm.

iv. “Emergency STOP” should be written in red or black letters on the circle.

v. Attention should be paid to the location of the emergency stop button, to be placed outside.

vi. Considering the fact that the vehicles pass very close to one another during the race, it should be assumed that the whole circuit would be cut in the case of any unintentional contact with the emergency stop button, and precautions should be taken to prevent this situation in the shell design.

vii. Sample circuit breaker circuits are shown in Figure 8-a and Figure 8-b. When the emergency stop button is pressed, connection types in which all energy consuming units in the vehicle are not de-energised will not be accepted and such vehicles will not be able to enter the race.

viii. In technical inspections **it will be tested whether emergency stop buttons functionally operate when the vehicle is in operating conditions and when it is moving,** after the vehicle completes all other inspections successfully. It will also be checked whether both emergency stop buttons comprise a red button in the middle of a yellow circle with a minimum diameter of 8 cm and whether "Emergency" is written in red or black letters on the circle.

f) The overcurrent breaker is a circuit element that automatically cuts off the electrical current in the circuit in which it is located if it exceeds the limit value defined for a certain period. Fuses and circuit breakers (excluding the motor circuit breaker) shall be considered as overcurrent circuit breakers (it is acceptable to use high-speed electronic circuit fuses and high-speed fuses). Overcurrent breakers shall never replace emergency stop buttons. The connection cables to be used between the battery and the circuit breaker connected to the output and for motor connections must be at least 4 mm in cross-section. Cable thickness should be increased according to the current drawn by the motors. The maximum current transmitted by the cables must not exceed 5 times the value of the cable cross-section used in mm. The cut-off current of the overcurrent circuit breaker shall not exceed 7 times the cable cross-section used. The cables should be placed in a suitable cable sheath and no bare cable should be used. Cable beams should be clamped in a suitable manner. Vehicles that do not use cables of colours in compliance with the standards, whose cable thicknesses do not meet the criteria given here, whose cable ends are open, whose cables are not in the duct or sheath, whose duct or sheaths are not fixed, and whose cables are in a dispersed condition shall not pass the technical inspection.

g) In addition, for all conductors installed on the vehicle, the maximum RMS current that can pass through the conductor shall not exceed 5 times the conductor size in mm^2. For example, a 16-mm^2 cable is allowed to carry a maximum of RMS current of 80 A.

h) It is mandatory that the vehicles have a suitable circuit breaker at the battery outlets to cut off all the electricity of the vehicle. The use of a DA type miniature circuit breaker is recommended for driver and race safety. If an AC type

miniature circuit breaker or thermal magnetic breaker is used, its DC voltage and current breaking capacity should be suitable for the connected cable and load. Also, fuses or protective components should be used to feed loads that are connected to the battery or DC/DC converter (see Figure 14).

i) A diagram showing all power circuits of the vehicle's electrical equipment should be drawn in A4 size (21 × 29.7 cm) in accordance with the format given in Figure 11 and brought to technical inspections. If the drawing is not brought to the technical inspections or the final situation of the vehicle is incompatible with the circuit diagram drawn, the vehicle will not pass the technical inspection.

8. Telemetry

a) Telemetry is mandatory in all vehicles. Telemetry is a system where all the data of the vehicle specified below are collected by an electronic card with a micro-controller and transmitted to the monitoring center via a radio frequency module. By telemetry;
   i. Vehicle speed (See Speedometer),
   ii. Temperatures and voltages of the battery cells,
   iii. Motor temperatures and voltages,
   iv. Amount of energy remaining.

   These data must be transmitted. Ready-made or team-prepared micro-controller cards can be used for this system, but personal computers, laptops and other mobile devices cannot be used.

b) The transfer of the information in the four items listed above to the monitoring center (telemetry computer) via telemetry will be controlled during technical inspections. Teams that cannot show that information other than vehicle speed is transferred correctly in technical inspections will not complete the inspections and will not receive stickers to participate in the race.

c) It was previously observed that teams had difficulties in transferring vehicle speed information via telemetry. Therefore, an exceptional case was defined for the transmission of this information. Accordingly, as stated in “9.19 Speedometer”, teams that cannot display speed information via telemetry can enter the race with an external speedometer (mobile phone, bicycle speedometer, etc.) with a penalty of 5 Wh.

d) The telemetry system does not need to be utilized as an external unit if the vehicle control unit (VCU) performs the function given in item c-vii of 6.10.

9. Energy Management System (EMS)

a) For Hydromobile vehicles, software and hardware that optimises power flow

between the energy sources and the load can be regarded as an EMS. In order for the EMS to be accepted as domestic, the DC-DC converter must be designed and produced by the team. Figure 16 should be checked for details.

b) Teams that develop a domestic EMS will be responsible for the following items during technical inspections:

i. Demonstrating the EMS product physically,
ii. Providing general information about the EMS design and operating principles,
iii. Measuring and showing the current and voltage values at which the DC-DC converters operate.

10. Electronic Differential Application

a) Detailed information about the differential application to be used in electric vehicles is published on the website as an Annex.

b) It is expected that teams that design their own electronic differential application conform to the principles detailed in the abovementioned Annex. To this end, teams must provide sufficient information about the design steps and give correct and clear answers to questions about the application. Furthermore, in order for the electronic differential application to be approved as a domestic component, demonstration of the motor reference signals through a suitable digital platform integrated into the vehicle is mandatory. If necessary, the design will be validated using this digital platform by repeating the vehicle dynamic testing process described in "**Error! Reference source not found.**. Competition Week"

11. Vehicle Control Unit (VCU)

a) The vehicle control unit (VCU) is a central control system that acquires, analyses, and interprets various signals coming from different components and sensors of the vehicle to command and regulate the same sub-systems that those items belong to or other substantially distinct units. The VCU is an embedded electronic component enabling the control of several sub-systems implemented on the vehicle, such as the battery management system, the DC-DC converter, and the motor control unit, utilising information obtained from the same sub-systems. The VCU consists of software and hardware. A microprocessor, EPROM or flash memory, and some other electronic components make up the hardware. The software is low-level code written into the microprocessor.

b) Generally, the VCU is characterised as follows:

i. Numerous analogue and digital I/O data (low and high power):
    1. Power supply (required power for sensor),

2. Communication (CAN or similar),
3. Digital input/output,
4. Analogue input (feedback signal from sensor),
5. PWM output,
6. Frequency output,

ii. Different communication profiles (CAN, Flexray, KWP2000, or similar),
iii. Power device control/interface,
iv. Intelligent communication interface adaptor.

c) The VCU is generally expected to perform the following main functions:

i. **Motor Torque Control**: It will receive the acceleration reference information from the vehicle driver and provide the reference motor torque signal in a way that will improve both driving quality and energy efficiency. Thanks to the motor torque control algorithm, the necessary safety functions, such as providing predefined acceleration and deceleration measures, current limiting during sudden load changes, and limiting of overspeed will also be provided.

ii. **Regenerative Braking Optimisation**: It will take the deceleration reference from the vehicle driver and convert it to the motor torque reference, which is required for additional electrical braking to increase energy efficiency without interrupting mechanical braking. Regenerative braking optimization will prevent overcharging, taking into account the state of charge of the battery.

iii. **Vehicle's Energy Management System**: It should limit the excessive use of energy resources in the vehicle and optimise the use of energy.

iv. **Management of Vehicle's Communication System**: This means converting different communication protocols in vehicle modules into a common protocol (e.g., Canbus), being manageable, and generating control signals.

v. **Diagnostics**: Evaluation of signals coming from various sub-systems to detect and diagnose possible faults occurring during operation and informing the driver of suggested corrective actions in terms of the VCU screen.

vi. **Monitor Vehicle's Condition and Warning the Driver**: Demonstration of critical data reflecting the current situation of the vehicle, such as vehicle speed, temperatures of the components, and battery and motor voltages, via in terms of the VCU screen.

vii. **Signal Acquisition and Data Transfer**: Vehicle speed, battery cell temperatures and voltages, engine temperatures, voltages, and remaining energy amount data are collected and transferred to the monitoring centre via the RF or GSM module. In addition, log records of transmitted data must be maintained.

d) The developed VCU will not be approved as domestic unless it performs **at least three of the above listed functions on a single mainboard**. During technical inspections, the teams claiming to have domestic VCU should provide the following items:

i. The final VCU hardware with a detailed verbal description,
ii. Comprehensive information about the main functions and the mandatory signal acquisition and data transfer function,
iii. A clear description of the communication protocols used between the VCU and the other sub-systems,
iv. Demonstration of the signal acquisition and data transfer function,
v. Demonstration of the logging function in the data centre.

e) Vehicle sub-systems recognize the surrounding environmental conditions from the available sensor data, evaluate these sensor data, and send commands to the actuators or other components. For example, the existing Electromobile vehicles' battery management system activates the flasher of the vehicle when the temperature of the battery exceeds the specified limit. However, it cannot take any preventive action to inhibit very high battery temperature. If there is a VCU, the desired electric motor power can be limited according to the temperature of the batteries. Even if temperature continues to increase, all current flow can be set to zero, and if temperature continues to increase it can open the emergency contactors. As described in the example, the VCU collects all information, evaluates the collected data according to written algorithms, and sends commands to the actuator to apply the decision.

f) In order to collect data from all sub-systems, to evaluate them, and to send commands, there must be a communication protocol for the VCU (*Figure 12*).

12. Insulation Monitoring Device

a) The insulation monitoring device measures the insulation resistance between the earth and electrical systems that are insulated from the earth. If there is insulation failure, the device gives a warning or shuts down the system. Insulation loss between system and earth or chassis in electrical energy generation systems, storage systems, or electrical vehicles can lead to major failures and accidents that may potentially be fatal.

b) Insulation monitoring devices in electric vehicles are connected between the high-voltage sub-systems and chassis and make measurements with reference to a resistance value that may create a life-threatening current flow risk. If the measured resistance value falls below the reference limit value, it is expected to give a warning and shut down the system. The reference lower limit value (battery peak voltage) × 100 Ω/V can be taken. For example, in a vehicle with a

highest battery voltage level of 100 V, the lowest lower limit for insulation resistance is 10 kΩ. Increasing this limit to higher values (e.g., 100 kΩ) is recommended as this will increase the level of safety against electric shock.

c) The insulation monitoring device must be connected between the positive and negative terminals of the battery and the vehicle chassis as shown in Figure 20. When the equivalent resistance between these terminals and the chassis falls below the reference lower limit value, it should give an audible warning of 80 dB at a distance of 2 m. The insulation resistance value must be displayed on the screen of the insulation monitoring device or on the VCU screen, if available. At loss of insulation, there is no need to de-energise the vehicle during the Efficiency Challenge races to prevent the vehicle from withdrawing from the race. In a safe vehicle electrical system without loss of insulation, the insulation resistance between the chassis and the electrical system is around several megaohms. It is expected that the insulation monitoring device should not reduce the current insulation resistance below 1 MΩ after being connected to the system. In other words, the insulation monitoring device should not connect the battery's plus or minus terminals to the vehicle chassis with an impedance of less than 1 MΩ.

13. Steering System

a) An automobile steering system mostly uses a rack and pinion system to adapt the rotational movement of the steering wheel to the linear movement of the steering rod (tie rod). For good maneuverability, it is recommended that the driver's steering be turned to full lock with less than approximately 180 degrees of turn to either side. This situation causes high forces in the steering wheel. The tie rod is rigidly connected to the wheel and is the handle that rotates the wheel around the steering axis. Both the length of the rod and the rack and pinion gears determine the relationship between the turns of the steering wheel and the turn of the wheel. They are the factors that change the steering force's feeling by the driver. The steering column must be mechanically connected to the pinion gear in a splined or splined shaft structure to prevent separation of the pinion and the shaft.

b) The steering angle has a maximum steering angle of 30 degrees at the wheel. The 30-35 degree range is the ideal steering angle and the design should take a value within this range. The steering system must have restrictions that prevent excessive steering in both directions.

c) There should not be more than 10 degrees of gap in the steering system.

d) The steering system must have a rack and pinion structure and must be mechanically (screw-nut) connected to the vehicle chassis and must be immobile. Safety wire or fiber nut should be used in the nut-bolt connections

used in the steering system.

e) It is recommended that the pinions and racks used in steering systems are manufactured from steel materials that are resistant to abrasion and high strength.

f) The steering angle should be designed in such a way that it does not hinder or strengthen the driver's movements according to the seat position.

g) In order for the steering system to be considered as domestic production, teams must do the following:

i. The technical drawing of all the elements used in establishing the relationship between the rotation of the steering wheel of the vehicle and the rotation of the wheel and the three-dimensional assembly CAD model of the whole system must be prepared. Each part must appear as a separate element in the CAD model. CAD file should be submitted with .stp extension.

ii. According to the steering wheel turning angle, the inner and outer wheel turning angles should be calculated and displayed graphically. Also, according to the steering wheel's maximum turning angle, the maximum turning angles of the wheels should be indicated on the graph. The chart should include the angle of turns of the wheels in both right and left turns.

iii. The steering wheel has to turn left and right at least 180 degrees and at most 360 degrees, and this turn causes the wheel to rotate. During the rotation of the wheels, there should be at least 1 cm space between the wheels and any part on the shell or vehicle.

iv. According to Ackerman principle, the minimum turning radius of the vehicle must be calculated. It is necessary to maintain the same radius in left and right turns.

v. According to Ackerman principle, the angle values of the outer wheel should be plotted according to the angle of the inner wheel and the results obtained by showing the actual values measured on the vehicle on the same graph should be compared and interpreted.

vi. When designing the wheel geometry, it should show which calculations or analyzes were used to determine the values of Caster, Camber and Toe-in.

vii. The control of the calculated and given design files will be done on the vehicle. The design and the car must be the same.

14. Door Mechanism

a) The designed door system will be considered as domestic if the following listed

features are found in the design of the doors used for access to the vehicle:

i. The vehicle should have 2 doors opening from both sides, the dimensions of the doors should be the same, the surface area of the doors should be at least 0.4 m2.

ii. 3-D CAD drawing of each of the parts in the door system and a 3-D dimensional montaged CAD drawing of the whole system must be prepared. The file should be submitted as .stp extension

iii. The door should be hinged to the vehicle body at at least two points. Teams need to show which calculations or analyzes are based on the selection of hinge locations and dimensions based on door geometry and physical properties.

iv. The entire outer frame of the door must be in contact with a surface of at least 2 cm wide on the vehicle body.

v. It is necessary to use a seal between the door and the vehicle body.

vi. The door must be lockable with a key. The door must not be opened by the door handle movement without opening with the key.

vii. The door should be closed with only the pushing force, without interfering with its handle.

viii. An object of 2 mm thickness should not enter anywhere between the door and the body when the door is closed.

15. HYDROGEN LINES AND METAL HYDRIDE HYDROGEN CYLINDERS

Technical rules of hydrogen lines and systems used in the Hydromobile category can be found below.

a) Low-temperature metal hydride hydrogen cylinders (maximum of 15 bar) may be used in vehicles. These cylinders must not be replaced during the race and no fuel (hydrogen) additions may be made to the existing tank.

b) A pressure safety valve must be provided at the outlet of the metal hydride hydrogen cylinders to evacuate the gas in the event of excessive pressure before entering the fuel cell. The output of the safety valve should be outside the vehicle, perpendicular to the ground, and the evacuation line output should be outwards from the vehicle.

c) A gas flow safety valve (flame trap or check valve) should be provided following the output of the metal hydride hydrogen cylinders, before entering the fuel cell.

d) The vehicle should have the following fire safety measures:

i. A thermocouple must be provided on the surface of the metal hydride cylinders to measure the temperature. The thermocouple must transmit the temperature measurement values to the temperature indicator in the vehicle's cockpit.

ii. The temperature indicator should be electrically connected to a warning flasher.

iii. An audial and visual alert should be emitted by the flasher and the solenoid valve should close when the surface temperature of the metal hydride cylinder goes 10 °C above the maximum operating temperature of the metal hydride as declared by the manufacturer (e.g., T > 55 °C).

iv. The flasher should be placed where the visual alert can be seen by the referees and the driver during the race. The diameter of the flasher should not be less than 4 cm and the height should not be less than 5 cm. The flasher should be red and rotating with a reflector.

e) The cylinders should be located behind a protective shield with mechanical resistance for protection against mechanical impacts from the outside. The cylinders with the protective shield can be placed behind the driver's seat or at the front of the vehicle beyond the windscreen. Cylinders located inside the vehicle should be located together and behind the protective shield, connected with resistant belts or clamps, and in the form of bundles. The protective shield should allow the natural ventilation of cylinders.

f) The section where the cylinders are located should be designed so as to not be subject to static electricity.

g) The hydrogen line should not pass through the cockpit. All valves and fittings used on the hydrogen line should be of 316 quality and stainless steel or brass, and pipes should be of 316 quality and stainless steel or PTFE (Teflon) material. Changes may be demanded by the technical team if any violations are observed related to safety during technical inspections. While designing the parts of the vehicle related to hydrogen gas and mounting these parts, the requirements of the following standards must be taken into account:

i. ISO/TR 15916:2004 - Basic considerations for the safety of hydrogen systems

ii. ISO 16111:2008 - Transportable gas storage devices - Hydrogen absorbed in reversible metal hydride

iii. BSI BS EN ISO 1114-1:1998 Transportable gas cylinders-compatibility of cylinder and valve materials with gas content - Part 1: Metallic materials

iv. ISO 11114-2:2000 Transportable gas cylinders-compatibility of cylinder and valve materials with gas content - Part 2: Non-metallic materials

h) A stainless steel or brass globe valve of 316 quality (security valve) must be provided for a second line of safety on the hydrogen cylinders-fuel battery line. The valve should be located in a place where it can be reached by the driver and inspected. An example of a flow diagram for gas lines is shown in Figure 13. Two different types of holes can be drilled in the safety wall for access to the valve as shown in this figure. The teams can also create a different flow diagram by considering the safety of the driver. This flow diagram should be shown in the technical design report and it will be checked during the technical inspections.

i) During technical inspections, technical specification documents and certificates will be checked for all materials used on the hydrogen line (pipe, valves, and connection elements).

j) There must be a hydrogen sensor in the area in which the fuel cell is located. In the event of the presence of 2% hydrogen in volume in the environment, the hydrogen sensors must emit an audible alarm of 80 dB to be heard at 2 m and shut down the solenoid valve.

16. PHYSICAL SPECIFICATIONS

a) It is expected that vehicles are suitable for urban driving and take into account efficiency. Fort his purpose, the vehicles (within the specified dimensions) are required to be et least (apprx. 1,70 m long and 70 kg weight for driver and passenger) with two seats and 4 wheels.

***** From 2022, the seats in the Vehicle will be side by side.**

16.1. Vehicle Measurements

a) Vehicle height must be a minimum of 100 cm and less than 1.25 times the vehicle width (100 cm < vehicle height < vehicle width × 1.25 (150 to 225 cm)). See Figure 5-I, Dimension “H”.

b) The distance between opposite wheels must be greater than half the width of the vehicle.

c) The vehicle width must not be less than 120 cm or more than 180 cm (119 cm < vehicle width < 181 cm). See Figure 5-I, Dimension “A”.

d) Vehicle length must be a minimum of 200 cm and a maximum of 425 cm. See Figure 5-I, Dimension “L”.

***** From 2020, the vehicle length will be maximum 350 cm.**

e) Track width of the front wheels must be a minimum of 100 cm, and the track width of the rear wheels must be a minimum of 80 cm. See Figure 5-I, Dimension “W_fr” , “W_back”.

f) The wheelbase distance must be a minimum of 130 cm. See Figure 5-I, Dimension “B”.

g) The distance between the seat and the ceiling on the space reserved for driver and passenger mus be at least 85 cm and the distance between the seat and the windshield should be at least 65 cm. Distance controlling will be done by the performance of the emergency evaluation test.

h) The ground clearance of the vehicle must be at least 10 cm. Figure 5-I dimension “C”. During the technical inspections, the vehicle will be checked whether it is within the lines drawn in the control area. Ground clearance will be checked with a rod that is 9 cm height. That rod must move without touching the underside of the vehicle. The detail of how to measure related substance in the vehicle dimensions in technical controls is shown in Figure 5-I. Ground clearance control will be performed while the pilot is sitting in the vehicle.

i) There is no lower limit fort he vehicle weight. Vehicles that the jury believes to be unsfe and whose doors and other parts will be damaged by the wind will be expelled due to security violation.

16.2. Vehicle Body

a) The vehicle body must be fixed in such a way that it includes all mechanical and elctrical parts. All parts must be completely inside the vehicle body when viewed from the front, back, or top. The shell of the vehicle shall not be in contact with the road, tires, or any other component. In technical controls, if needed, the vehicle should be produced with a cover design that can be opened in front of and behind the Shell in order to make under-shell inspections. It shall be possible to access/inspect internal parts by opening these covers if required.

b) In cases where brake wires, pipes, hoses, electrical cables and electrical components are required to be mounted outside the vehicle, theese parts must be protected from the damage risks such as stone impacts, rüşt or mechanical failures etc.. It is required that all equipment be mounted inside the vehicle shell be protected against risks such as fire and short circuits.

c) The vehicle body must not have any sharp and pointing protrusions that could damage other vehicles during the race. The cocpit must be complately isolated from the external environment. The cocpit and the driver must be protected from foreign materials such as Stones that may come from the road.

d) The vehicle should not be designed as a roadster; the upper part of the vehicle should be complately closed

e) During technical controls, all elements that may pose a risk to the driver and other vehicles will be checked.

16.3. Door

a) It should be easy for the driver and the passenger to enter and exit the vehicle. There shall be at least one door that opens from the top or two doors that open from the sides, allowing the driver to get out in the event of vehicle turnover Kapı ölçüleri en az 50 x 80 cm olmak zorundadır.

b) Any door to be used for acces to the vehicle should be fixed to the body with a reliable fastener such as a hinge or slide mechanism. The door mechanism should be able to close by itself, and when opened, it should be able to stand firmly without being deformed from the hinge part.

c) The door lock mechanism must allow the door to be opend from inside and outside in emergencies. The locking mechanism should automatically lock when the door is closed and should not allow the door to move back fort hor up and down. While the door is closed, the door lock must automatically engage in the latch slot fixed to the vehicle body without inferring with the door handle. Example door lock mechanisms are shown in Figure 7-a

d) Door mechanisms that do not have an opening latch on the inside and outside of door will not be accepted. Unsafe and non-durable locking mechanisms such as plastic clamps, sliding locks, locks that can only be opened by means of a key and operate with the principle of tight fit will not be accepted. Figure 7-b shows some examples of innappropriate locking mechanisms.

e) Thin door bodies made of materials such as carbon fiber constitute a security violation since they cannot maintain their solid form (rigid structure). Such door bodies cannot provide sufficient integration with the vehicle body in the closed state due to the long distance between the hinge and the door handle, and cause unintentional opening. In order to avoid this problem, the teams are expected to add metal support elements to the door body and strengthen the existing structure and bring the door to a solid form (rigid structure) that moves as a whole

f) In the door mechanism, if the door cannot be closed without manual intervention to the door handle and if the mechanism is not solid, the team will be penalized with 2 Wh penalty points and the team will be allowed to participate in the race.

g) It is not accepted to fixate the door with duct tape and to fix the door with plastic clamp from the inside. If similar situations are observed before or after the race, the team will be dismissed.

16.4. Weight

a) Since the main purpose in the competition is efficiency, there is no lower limit for vehicle weight. However, if a vehicle is not deemed suitable in terms of driver safety, it could be disqualified from the competition by the Jury.

16.5. Wheels

a) The wheels to be used in vehicles should comprise a hub, rim, and tyre.

b) There is no restriction on the rim dimensions of the wheels and the material they are made of, it does not extend beyond the vehicle.

c) TUBITAK will supply 90/90-16 size tires to the teams participating in the race. The ideal rim dimension (Fiigure 5-m “Dimension A”) is 55 mm fort he given tires and it has been reported by the tire manufacturer that this value can be maximum 63,5. The use of wider or narroer rims is at the dicretion ot the teams and the teams that creates risk fort he safety of the race will be banned from the race.

d) The teams can not use tires other tnaj the tires provided by TUBITAK

e) Any method of heating or chemical treatment of tires is prohibited.

f) It will be checked by looking at the label of the tire in technical controls.

17. SAFETY EQUIPMENT

a) The vehicles, design and manufacturing of which can cause danger, will be expelled from the competition by the referees and the Jury.

17.1. Location of the Battery Package

a) Location of the battery group must be separated from the cockpit by a fireproof (at least for 5 minutes) and durable divider (metal etc.). There must be no passage between the battery group and the cockpit. In case of any space between the fireproof divider and the shell of the vehicle, the spaces must be covered by a fireproof, metal based tape.

17.2. Location of the Fuel Cell Stack

a) For the vehicles in Hydrogen Vehicles category, the space, in which the fuel cell will be placed must be separated from the cockpit by a durable and fireproof (at least for 5 minutes) divider (kestamite etc.).

17.3. Location of the Battery Package and the Fuel Cell Stack Together

a) For the vehicles in Hydrogen Vehicles category, the battery package and the gas connection lines (hoses, valves etc.) must be strictly separated from each other. For this purpose;

i. The battery package and the fuel cell stack must be located in different places in the vehicle (e.g. in the front or back of the vehicle) **or**

ii. The battery pack and the hydrogen gases must be separated with durable materials.

17.4. Brakes

a) A dual-circuit hydraulic brake system operated by a single pedal is obligatory. The same pedal shall activate all brakes. In the event of any breakdown in any circuit, the other circuit shall be effective on other wheels. Wire brakes are not acceptable.

b) Brake performance of the vehicle will be performed on a braking platform. Figure 20 shows the dimensions of the platform for brake test. Length, height, and width of the platform are 485 cm, 85 cm, and 200 cm, respectively. Slope angle of the platform is approximately 10 degrees. It is expected that the designed vehicles are able to stay still without sliding on the braking platform during the braking tests carried out before and after the competition. Dynamic performance of the brake system is evaluated with an extra test conducted on the braking platform which consists of two steps. In the first step, while staying still on the platform without moving, the driver will be asked to release the brake pedal completely so that wheels start turning. Then in the second step, the driver will apply full brake to prove that vehicle can stay still on the platform again without moving and not having any sliding wheel.

c) Vehicle shall be precisely aligned with the platform either by driving or pushing. It is not allowed to put the vehicle on the platform by carrying. Teams should consider the dimensions of the platform during the design phase of the vehicle.

d) The braking tests on the braking platform will be performed while the vehicle is placed on the platform with its front side pointing the downward direction.

e) The brake test will be repeated after the competition.

f) In case of an unavailable braking platform during the competition, an alternative brake test which is carried out by pushing the vehicle by two persons corresponding to the application of 650 N pushing force will be applied. The wheels of the vehicle shall not move during the pushing test.

17.5. Fastening Equipments

a) Heavy loads to be carried in the vehicle shall be fixed in place tightly (e.g. spare tyre, recharging cable, tool bag).

17.6. Safety Belts

a) It is necessary to use a safety belt that is fixed at four or five points according

to FIA standards *(See Figure 3*). Safety belts that do not meet FIA standards will be considered as a reason for disqualification due to violation of safety rules.

b) Safety belts could be any brand that has a FIA certificate. The passenger and the driver must have separate belts and the FIA certificate of both belts will be checked in technical inspections.

17.7. Helmet, Racing Suit, Gloves, and Shoes

a) Closed and open type racing helmets can be used. Helmet use is mandatory.

b) A racing suit with FIA certificate, specially manufactured for races, will be used to protect the driver in the event of combustion (see Figure 1 and Figure 2). It is suitable for gloves and shoes to have FIA certification or to be made of fireproof material (leather etc.) Hardware that does not meet these specifications will not be accepted. If equipment that is not FIA approved but meets safety requirements is used, teams will be penalized with a 5 Wh penalty due to the inability to use the race allowance effectively. These equipment can be any brand with FIA certification.

17.8. Fire Extinguishers

a) It is obligatory to provide one 2-kg or two 1-kg fire extinguishers in the vehicles. The extinguishing substance should be dry chemical dust in accordance with type C fires.

b) In technical inspections, it shall be checked that the fire extinguishers are located somewhere easily reachable, that they are fixed but can be removed from their place, and that the expiry date has not passed.

17.9. Roll Bars and Roll Cages

a) Roll bars and roll cages must be made of material having a minimum yield strength of 200 MPa at each point.

b) The roll bars should be connected by bolts or welding at a minimum of four points on the roll cage or body and be perpendicular to the vehicle’s bottom.

c) The distance between bolts should be a minimum of 2.5 D, and they should be a minimum of 1.5 D from the sides.

d) The minimum welding thickness should be half of the body thickness of the thinner of the welded parts, provided that it not be less than 3 mm. Max (3 mm, 0.5 tmin), tmin: body thickness of the thinner of the welded parts.

e) Minimum welding length should be 5-fold the welding thickness provided that it not be less than 20 mm max (20 mm, 5 t), t: welding thickness. For example, if there is a welding thickness of 5 mm, 25 mm of uninterrupted welding should

be used.

f) Profiles used for the roll bar and roll cage have to be closed and rolled pipe or box profiles. Open profiles and profiles closed with welding will not be accepted. Vehicle chassis made of carbon fibre and honeycomb material are not accepted as roll cages. Carbon fibre roll bars and roll cages independent of the body may be used if they meet the profile conditions defined above.

g) The box or pipe profiles to be used must have a minimum diameter of 3 cm and a thickness of 3 mm.

h) The profiles to be used must be $h/t < 20$. For example, the body thickness of a box profile having a side length of 8 cm or a pipe profile with a diameter of 8 cm must be 4 mm or more.

i) The bolts used must have a minimum diameter of 8 mm and 8.8 grade.

j) The distance between bolts must be a minimum of 2.5 D and they must be a minimum of 1.5 D from the sides.

k) No bore shall be opened other than the points where roll cage elements are connected to one another on the roll cage, and no welding shall be done. Opening bores for decreasing the weight will be cause for disqualification due to violation of safety rules.

l) Roll bars are required to be mechanically supported at a minimum of 4 points. In addition to the mechanical connections of the rear roll bar, use of supporting cross beam for the rear roll bar is mandatory (Figure 5-f). Unsupported roll bar designs longer than 50 cm shall cause for disqualification due to violation of safety rules.

m) Roll bars and roll cages are independent from the chassis and must have closed cross-sections.

n) The front roll bar must start at least 3 cm above the top point of the steering wheel circle. Extension of the front roll bar by making additional connections is not accepted.

o) The rear roll bar must start a minimum of 5 cm above the helmet when the driver is sitting in the racing position. Extension of the rear roll bar by making additional connections is not accepted.

p) The top point of the helmet when the driver is sitting in the racing position should remain below an imaginary line drawn between the tops of both roll bars.

q) If it is observed during the race that the helmet of the driver is above the roll bar, s/he will be disqualified from the race.

r) The feet gap of the roll bar must not be less than half of the vehicle width in the cross-section.

s) It is sufficient to provide a roll bar only for the driver's seat.

t) Beams that provide sufficient resistance to be used in the side frames of the vehicle shall be accepted as roll bars (provided that an imaginary line between front and rear roll bars remains above the driver's helmet).

u) It is expected that the vehicle has a profile or a strong body on the side plane so as to protect the vehicle from side impacts.

v) Teams employing roll bar and roll cage practices that are not in compliance with the rules but are considered to be safe by the Jury can participate in the race with a penalty of 5 Wh. For example, even if the design of a team that uses a carbon fibre vehicle chassis as a roll cage is found to be safe, the roll bar and roll cage will get a penalty score of 5 Wh since they violate the rule of creating a cage independent of the vehicle.

w) In technical inspections, the thickness of the material used for roll bars and roll cages, the places where they are fixed, the bolt or welding used for fixing, the distance between the place of fixing and the longest part, and the complete protection of the driver from outside impacts while in a sitting position will be examined.

x) In order for the profiles that pass through the vehicle's bottom to be accepted as a roll cage, the distance between the closest part of the driver's roll cage and the surface of the roll cage that looks inside the vehicle should be a minimum of 20 cm.

y) Sample designs are given in Figure 5.

17.10. Rear View

a) It is necessary that on both sides of the cockpit, rear view mirrors with a minimum reflection area of 50 cm^2 each be provided.

b) In the inspections, it will be expected that the text to be shown from behind the vehicle can be seen and read by the driver by means of the mirrors.

17.11. Tow Bars

a) One steel ring should be provided on the front and rear part of the vehicle with a minimum internal diameter of 20 mm, attached to the chassis, located in an easily accessible manner, painted red or yellow, and easily seen from outside.

17.12. Windscreen, Windows, and Wipers

a) Windows that do not shatter during collisions should be used (Plexiglas, polycarbonate, or metal mesh). If glass is used, it should be transparent and not obscure the sight of the driver.

b) Wipers should be provided for the windscreens. In technical inspections, it is expected that the wipers should perform the movement of cleaning the windscreen without any aid continuously a minimum of 5 times.

17.13. Cockpit

a) It should be designed in such a way that it does not tire the driver even in long distances. The main equipment required to drive the vehicle should be designed in such a way that the driver can easily use his body without excessive movement and without loosening the seat belt. The cockpit should be of sufficient form to provide a sufficient amount of fresh air inside.

b) Entry and exit should be provided to the cockpit without the need for the assistance of others. In vehicles, the driver must be able to get out of the vehicle without assistance within a maximum of 10 seconds (see 9.22. Emergency Evacuation).

17.14. Seat

a) The seat must be firmly fixed to the chassis. The back support should not be angled more than 30 degrees with the vertical. In seat selection, it is mandatory to choose products that surround the driver, prevent sliping in two directions and have FIA certification.

b) The same type of seat must be used for the driver and passenger. Seats can be any brand with FIA certification.

c) If seats that do not meet the racing seat standards but meet the safety requirements, a 5 Wh penalty will be applied due to the inability to use the race allowance given to the teams effectively.

d) Seat assemblies formed by shaping the lower body of the vehicle in the form of seats will not be accepted. An external seat is required.

e) The passenger seat and the driver's seat should be the same. The passenger seat and the driver's seat must be on the same plane. In designs that are placed back to back, there should be at least 10 cm knee distance.

f) During technical controls, the certificate on the seat will be checked. Certified seats are monoblock. Seats with folding features are not suitable

g) During the controls, both the driver and one passenger will be required to sit on the seats and fasten their belts. Designs that do not fit the passenger seat will

not be accepted.

h) The top level of the helmet of the driver sitting on the seat should be below the top of the seat. Otherwise, head restraints should be made between the seat and the top of the rear roll bar.

17.15. Steering Wheel

a) The steering wheel must be in the form of a closed ring. Open handles, such as in the form of a joystick, are prohibited since these could create problems in the event of an emergency evacuation.

b) In technical inspections, the fixation of the steering wheel, its location under the front roll bar, and its capability to be easily rotated will be checked.

17.16. Vehicle Components with Basic Functions

a) Since the teams make the main components specific to their vehicle designs, the rule booklet does not contain any detailed information about these parts. Control of the main components will be checked according to their performance during the dynamic driving test.

The issues related to the main components with basic functions are listed below:

i. Braking and drive control devices, load-carrying parts, wheel suspension, and safety belt fixing points; attention should be paid to the quality of such parts. Registered standard parts should be used when possible.

ii. Screws should be of sufficient length and should not loosen by themselves.

b) If technical checks on parts with basic functions identify situations that risk race and driver safety, regulation will be requested from the teams.

17.17. Mitigating the Risk of Injury

a) The protrusion of parts inside the vehicle should be avoided. Since sharp or protruding edges will not be permitted, these should be cushioned as much as possible. Sharp ends outside the vehicle should be sufficiently covered or cushioned. Parts of the vehicle that cannot be covered should be marked in yellow and black.

b) Parts that constitute a risk for the driver sitting in the vehicle and other vehicles will be checked with a visual inspection.

17.18. Horn

a) The vehicle should have a certified acoustic horn that sounds continuously for three seconds at a sound level of 80 dB(A).

b) In technical inspections, the driver will be requested to sound the horn for 3 seconds; it will be measured with a sound-level meter at a distance of 2 meters.

17.19. Speedometer

a) There must be a speedometer that will be located within the driver's field of view.

b) In technical inspections, the speedometer will be checked while driving in the dynamic control test from the telemetry computer which is mandatory for the teams.

17.20. Break Light and Headlight

a) Two brake lights should be placed at the rear of the vehicle that must be seen from a minimum distance of 25 m in daylight, emit a red light, and be activated in the event of full or half-press of the brake. In technical inspections, it will be checked whether the brake lights are easily seen from a distance of 25 m.

b) Two headlights emitting white light should be placed on the front of the vehicle that can be seen from a minimum distance of 25 m in daylight. In technical inspections, it shall be checked whether the two headlights are easily seen from a distance of 25 m. In technical inspections, the driver will be requested to turn on and off the headlights using a button placed in the cockpit.

17.21. Reversing

a) The vehicle should be able to perform reverse movements with its own driving force. Reversing control will be made in dynamic driving control.

17.22. Emergency Evacuation

a) Teams that pass the controls of door, seat, safety belt, helmet, racing suit, gloves, and shoes shall satisfy the emergency evacuation test in order to be sure that the driver can leave the vehicle in case of a dangerous situation during the training laps or the race.

b) In the emergency evacuation test, the driver dressed in racing apparel (helmet, racing suit, gloves, and shoes) with seat belts fastened and a person from the team (preferably the reserve driver) with seat belts fastened, the driver's hands are at the steering wheel. They must leave the vehicle upon a command in 10 seconds without outside assistance while the vehicle's doors are closed.

17.23. Flag

a) The flag shall be in the form of a hard plastic plate with a minimum thickness of 2 mm and a rectangular shape of a minimum of 20 × 30 cm, provided that the lowest point is not below the “visible point”, and it may be attached to the vehicle

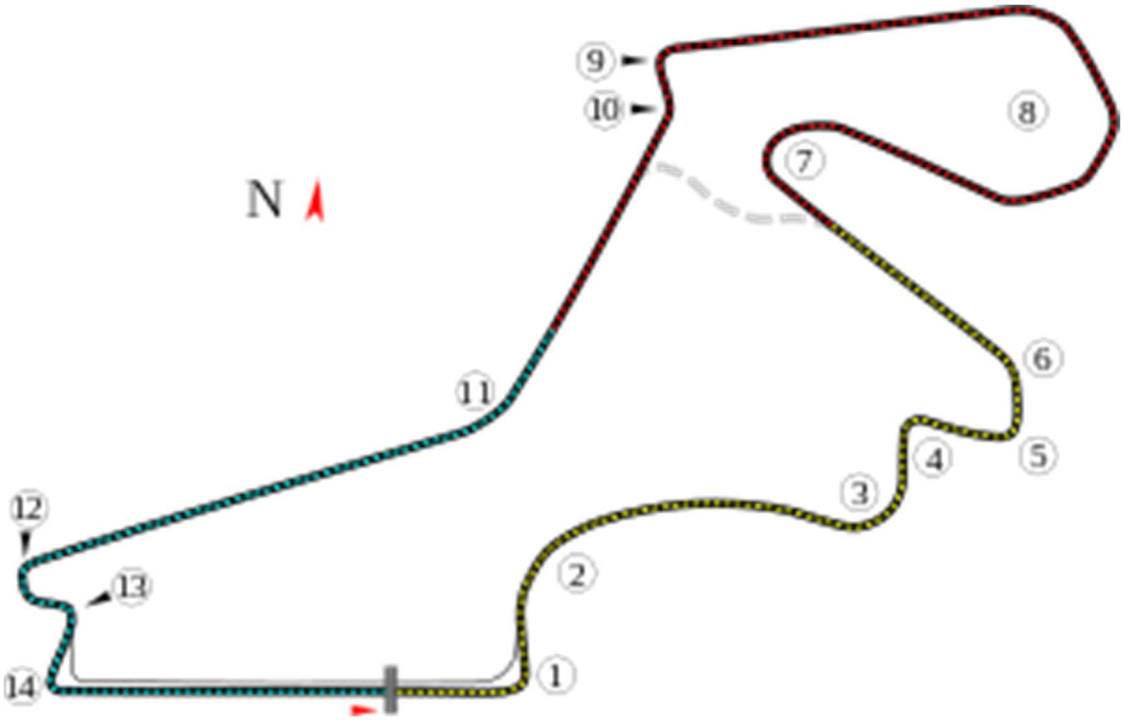
by a non-deformable pole. Teams that do not form a flag plate since it is not suitable for the vehicle design must stick the event logo up to the visible two sides of the vehicle as DDK deems appropriate. The logos to be used will be distributed by TÜBİTAK during registration.

b) The flag control will be done visually, it should be in a place that can be seen from afar.

18. THE ELECTROMOBILE AND HYDROMOBILE RACE

18.1. Track Information

Efficiency Challenge races will be held by using the 1-2-3-4-6-7-10-11-12-13-14-1 track of the IstanbulPark Track shown in Figure-1. The part of the race circuit indicated by numbers 7-8-9-10 will not be used. The length of the track consisting of 1-2-3-4-6-7-10-11-12-13-14-1 is approximately 4,000 meters and has a slope of at most 6%. You can find detailed information about the race circuit on the website https://intercitypark.com/hakkimizda/istanbul-park and websites that provide maps (atlas maps, Google earth etc.).



IstanbulPark Circuit

Satellite view of the IstanbulPark Circuit

18.2. Electromobile Final Race

a) In the race, every vehicle is expected to complete **7 laps** in a maximum of **60 minutes**. While evaluating vehicles with excessive laps, the distance travelled shall be considered as 7 laps.

b) The race formula has been updated according to the 5,4km circuit of Istanbul Park.

c) It is not important in terms of final ranking at which rank the vehicle completed the race. The energy measuring device to be given by TÜBİTAK beforehand and attached to the vehicles before the race will be used for the evaluations.

d) During the race, teams can enter the pit area and make mechanical or electrical adjustments to their vehicles, excluding those that may affect the energy measuring device and battery.

e) The ranking at the end of the race shall be calculated based on the score received by teams according to the following formula:

$$X = (Number\ of\ Laps) \times (70) - (\frac{\text{Energy Consumption Value}}{\text{Number of Laps}} + \text{Penalty} - \text{Award})$$

	Number of Laps	Time	Valid Number of Laps	Total Energy Consumption	Score, New Formula	Notes
	#	min:sec	#	Wh	#	
1	7	40:00:00	7	2652	111,14	Early completion is not important
2	7	49:00:00	7	1950	211,43	Vehicle with the lowest consumption
3	6	65:00:00	5	2700	-190,00	Last lap will not be valid
4	4	59:59:59	4	1800	-170,00	To be included in ranking
5	5	60:00:01	4	600	130,00	Last lap will not be valid, To be included in ranking
6	9	68:00:00	7	3650	-31,43	Additional laps shall not be calculated

Table 4. Sample Calculations for Electromobile.

Calculating the Score of Vehicle 4:

$$X = \text{Number of Laps of Team} \times (70) - (\frac{\text{Energy Consumption Value}}{\text{Number of Laps of Team}} + \text{Penalty Wh} - \text{Award Wh})$$

$$X = (4) \times (70) - \frac{1800}{5}$$

$$X = -170$$

f) Important Note: The formula may change depending on the conditions of the track where the race will take place.

g) In order to be eligible for the Performance Award in the Electromobile category, a team's race score must be at least 300.

18.3. Hydromobile Final Race

a) During the race, every vehicle is expected to complete 7 laps in 60 minutes.

b) The race formula has been updated according to the 5,4 km circuit of Istanbul Park.

c) It is not important in terms of final ranking at which rank a team completes the race. The energy meter and flowmeter to be fitted to the vehicles before the race will be used by TÜBİTAK for the assessment to be made.

d) During the race, teams may come to the pit area to make adjustments to their vehicles mechanically or electrically with the exception of interferences affecting battery, energy meter, and flowmeter measurement.

e) The ranking at the end of the race shall be calculated based on the score received by teams according to the following formula:

$$X = \text{Number of Laps of Team} \times 70 - \left(\frac{\text{Energy Measuring Device Value} + \text{Hydrogen Consumption Value} + |\text{Energy Measuring Device Value} - 3 \times \text{Hydrogen Consumption Value}|}{\text{Number of Laps of Team}} + \text{Penalty Wh} - \text{Award Wh} \right)$$

Teams may maximise their scores by drawing balanced energy from the battery and fuel cell.

	Number of Laps	Time	Valid Number of Laps	Total Energy Consumption	Total Hydrogen Consumption	Score, New Formula	Notes
	#	min:sec	#	Wh	Litres	#	
1	7	40:00:00	7	1326	442	237,43	Early completion is not important
2	7	49:00:00	7	975	325	304,29	Vehicle with the lowest consumption
3	6	65:00:00	5	1350	500	-50,00	Last lap will not be valid
4	4	59:59:59	4	900	350	-70,00	Will be included in the ranking
5	5	60:00:01	4	300	110	170,00	Last lap will not be valid Will be included in the ranking
6	9	68:00:00	7	0	1200	-195,71	Additional laps shall not be taken into account Continuing the race with a single source results in a low score

Table 5. Example of calculation for Hydromobile

Calculating the Score of Vehicle 4:

$$X = \text{Number of Laps of Team} \times 5$$

$$- \left(\frac{\text{Energy Measuring Device Value} + \text{Hydrogen Consumption Value} + |\text{Energy Measuring Device Value} - 3 \times \text{Hydrogen Consumption Value}|}{\text{Number of Laps of Team}} + \text{Penalty Wh} - \text{Award Wh} \right)$$

$$X = 4 \times 70 - \frac{(900 + 350 + |900 - 3\,x\,350|)}{5}$$

$$X = -170$$

f) Important Note: The formula may change depending on the conditions of the track where the race will take place.

g) In order to be eligible for the Performance Award in the Hydromobile category, a team's race score must be at least 300.

18.4. Energy Consumption Measuring Device

a) Energy consumption will be measured with an energy measuring device to be given by TÜBİTAK. The specifications of the device are as follows:

b) The device supplies its own energy from an internal battery.

c) There is an LCD screen that displays the energy consumption and the measurement duration.

d) Current measurement range is 0–100 A and voltage measurement range is 24–200 V. Power measurement accuracy is better than ±1%.

e) If the measurement ranges are exceeded for current or voltage, two times the limit values will be used to calculate energy.

f) Dual-way energy flow is considered while calculating the net energy. Therefore, regenerative energy will be discounted from the net energy.

g) A connection diagram between the device and the vehicle's electric system is shown in Figure 9. In order to connect the device to the vehicle, power connectors will be supplied and installed in the vehicle by TÜBİTAK staff before the races. Connector codes are 6810G2 or SA120B6-H.

18.5. Hydrogen Consumption Measuring Device

a) Hydrogen consumption will be measured by a flow meter to be provided by TÜBİTAK 5 days in advance of the race in calibrated condition.

b) The flow meter will be battery-powered and will have no electrical connection.

c) The flow meter will be connected to the hydrogen line before the fuel cell with a 6-mm connection (or ¼ inch) in a direction suitable for the gas flow (*Figure 15*), and it will be returned after completion of the race.

d) The flow meter must be located inside the vehicle where the driver cannot reach it and it must be easily readable from outside. The suitable location for integrating the flow meter into the vehicle will be determined based on advice from the Jury.

18.6. Number and Time of Laps

a) In the Electromobile and Hydromobile categories, it is expected to complete 7 laps in 60 minutes. Excessive laps will not be taken into consideration.

b) In order to be able to finish the race, the teams must complete the race in the pit area, and the vehicles unable to drive up to the pit area cannot be ranked.

c) If the teams start the race from the pit stop area due to a breakdown or being late to the starting position according to the announced time in the race program, their first rounds are not counted.

d) The number and time of laps of teams during the race are recorded by the transponders provided by TOSFED, which is responsible for sportive management of the race. Objections to the numbers and times of laps after the race shall be evaluated by TOSFED.

18.7. Determining the Ranking

a) The initial value of the energy measuring devices of all vehicles before the start of the race and the final values when the race is completed shall be read and recorded by the Jury. If two teams have the same scores according to these values, the one with the highest number of laps shall be ranked higher. In the event that the number of laps is the same, the vehicle that completed the race within the shortest time will be ranked higher.

b) The score received by the teams shall be used for the final ranking according to the formula explained above.

ANNEX 1: SAMPLE DRAWINGS AND FIGURES

Figure 1. Racing overalls

Figure 2. Racing gloves

Figure 3. Racing safety belt

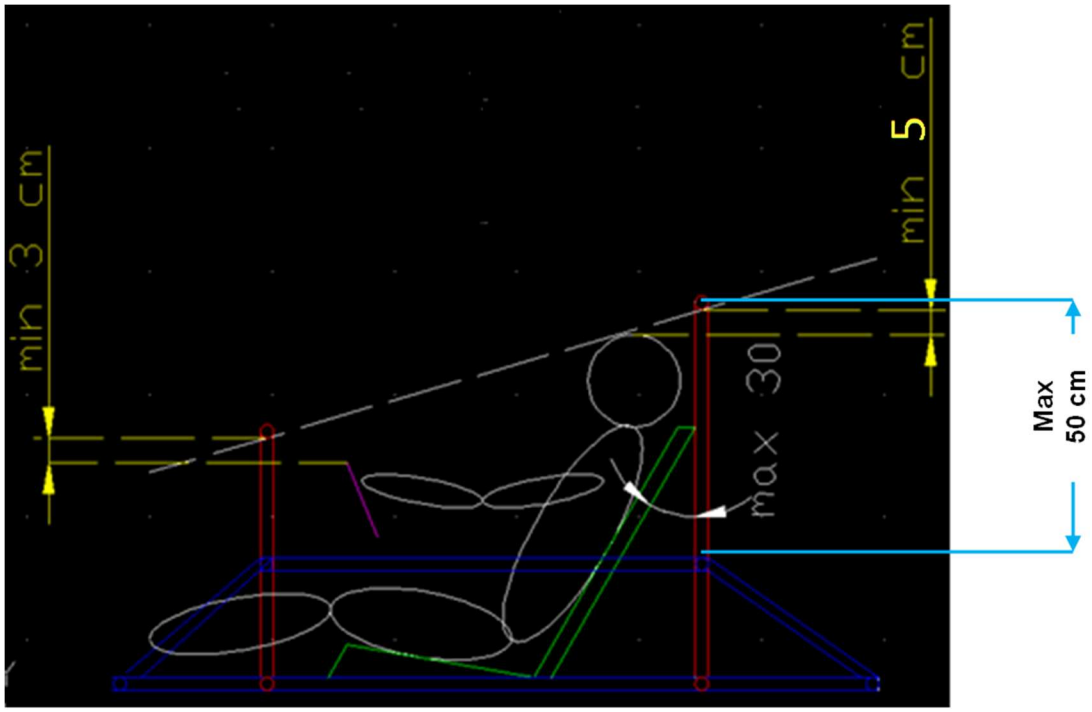


Figure 4. Sitting position of driver inside the vehicle and position of roll bars and seat

a) Roll bars are perpendicular to vehicle bottom
b) The front roll bar starts a minimum of 3 cm above the steering wheel ring
c) The rear roll bar starts a minimum of 5 cm above the helmet level of the seated driver
d) Driver seat fixed to the chassis is at a maximum angle of 30 degrees to the perpendicular
e) If there is a distance of more than 50 cm between the point where the roll bar connects with the roll cage and the highest point of the roll bar, a support should be welded between the front and rear roll bars.

Figure 5. Sample roll cage and roll bar designs

(Only a sample; the designs may be changed provided that the conditions specified in the rules are met.)

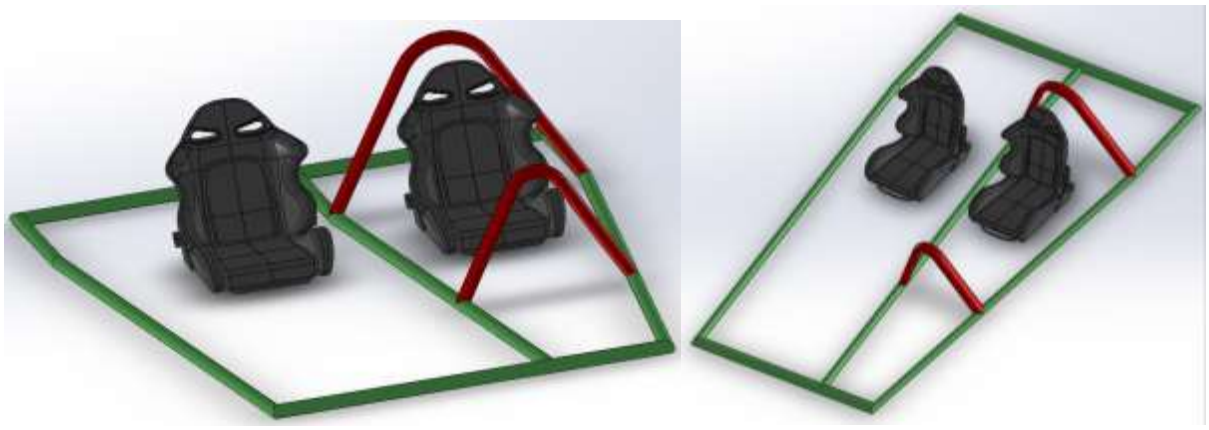


Figure 5-a

In Figure 5-a, it is shown that a roll bar could be provided only for the driver's seat in vehicles. A separate seat is required for the passenger. The seat in Figure 5-a conforms with the competition's rules. As can be seen above, a roll cage is provided that protects the vehicle against side impacts and will not block door entry. Designs similar to these will be accepted.

Sample drawings are for a single seat. Two seats must be provided in vehicles.

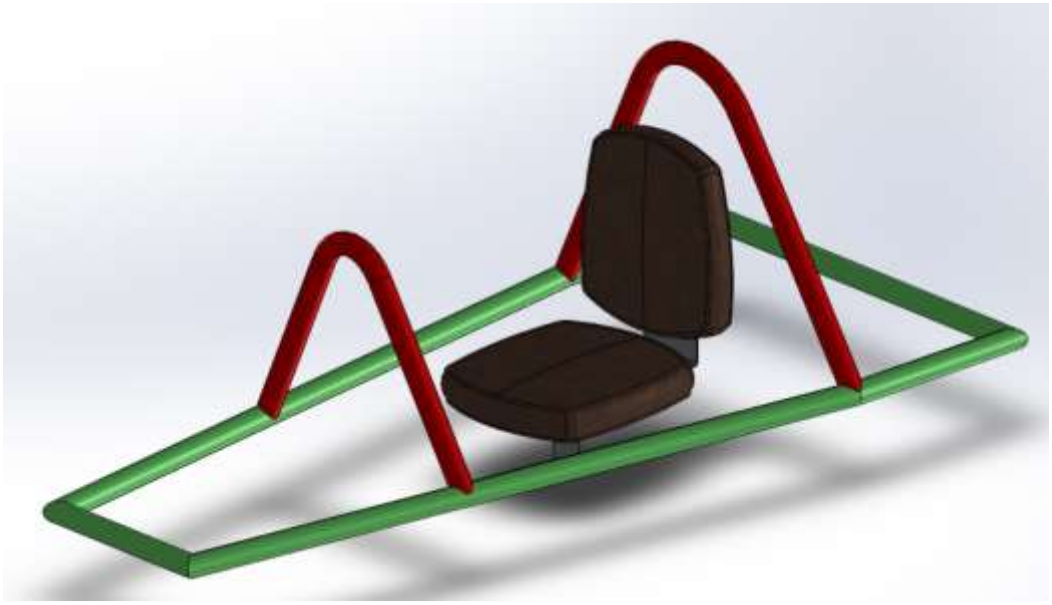


Figure 5-b

The design in Figure 5-b conforms to the competition's rules; however, the seat is not suitable since it does not protect the driver from the sides.

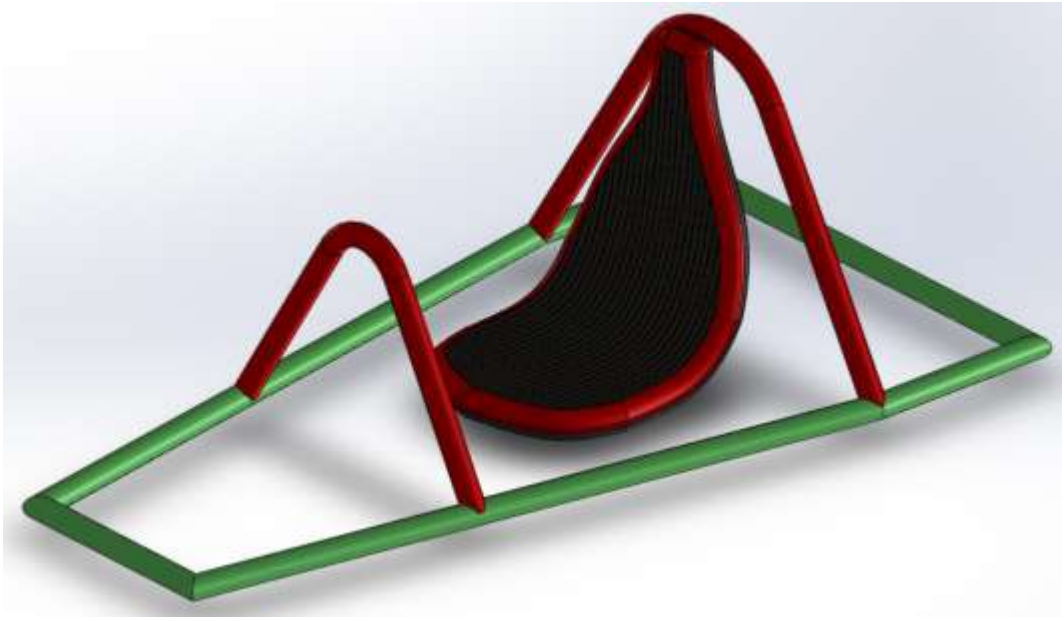


Figure 5-c

The design in Figure 5-c conforms to the competition's rules; however, the seat is not suitable since it does not protect the driver from the sides.

The seat should protect the driver from the sides as shown in the first drawing.

Figure 5-d

The seat type in Figure 5-d is suitable as a race seat. However, the part at the top or similar additions will not be accepted as a roll bar.

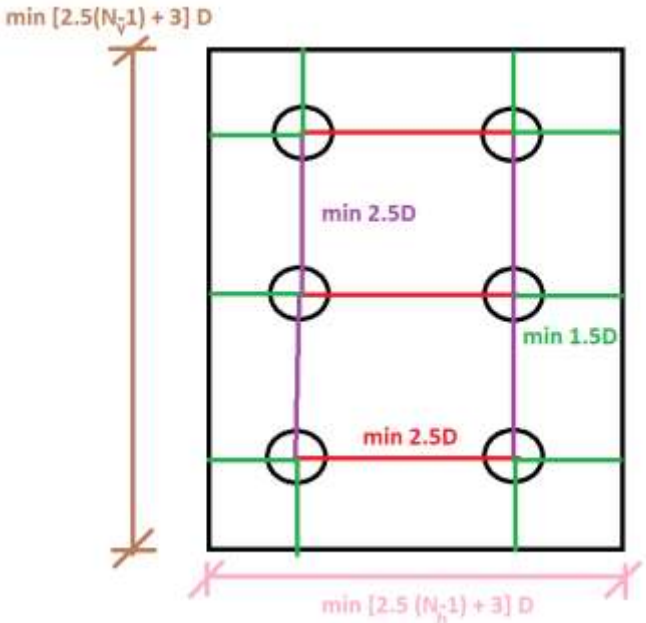


Figure 5-e.1

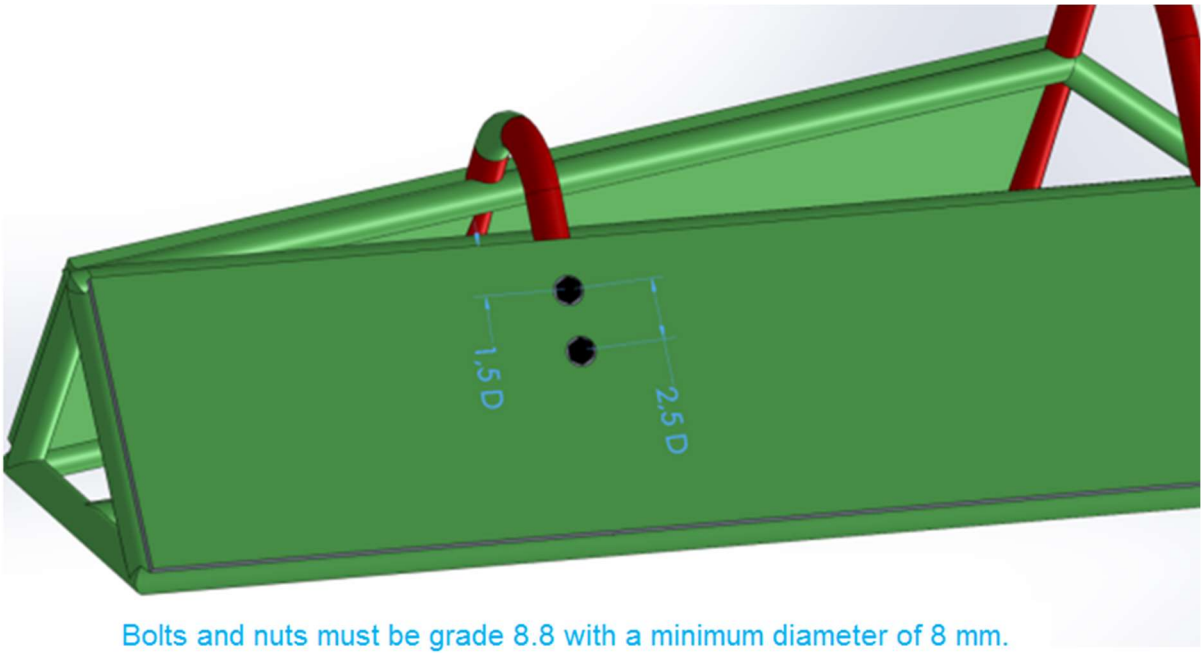


Figure 5-e.2

Figure 5-e provides technical drawings that demonstrate the minimum distance between the bolts and show how far the bolt should enter at minimum in the case corresponding to the edge.

a) The diameter of the bolt is D, as indicated in the rules for roll bars and roll cages, and it should be a minimum of 8 mm.
b) There should be minimum of 2.5 D between two bolts; namely, it should be 25 mm for an M10 bolt.
c) The distance from the side should be a minimum of 1.5 D, or 15 mm for an M10 bolt.

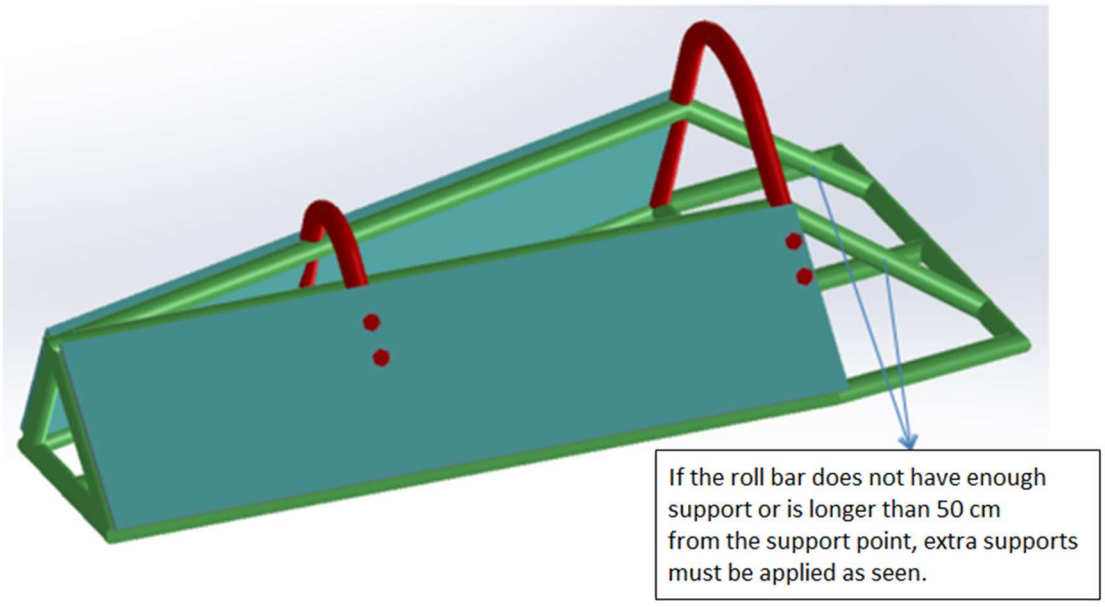


Figure 5-f

The illustration in Figure 5-f is only for defining the measurements. There is no need to screw the roll bars to the roll cage if it is welded or bolted.

Figure 5-g

In Figure 5-g, a carbon fibre roll bar used in a Formula G racing vehicle in 2014 is shown. According to 2015 rules, it cannot be used since it is not in a closed box or made of a milled pipe profile.

Figure 5-h

A honeycomb body shall not be accepted as a roll cage. It is required to use a separate suitable profile inside the vehicle in accordance with the rules.

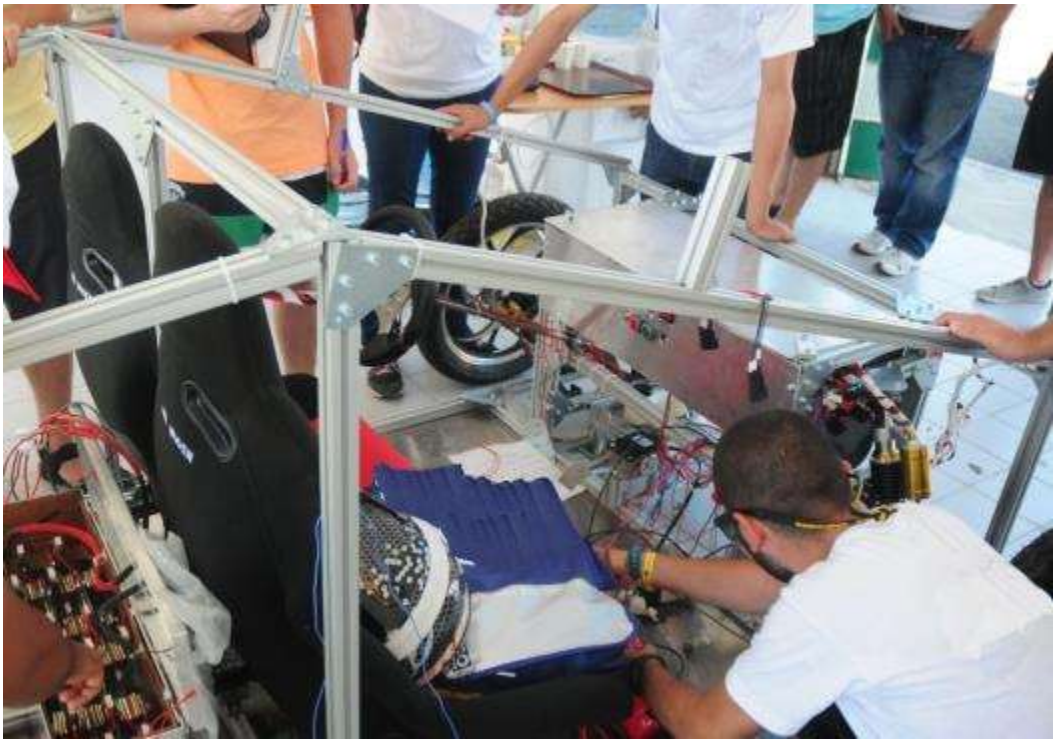


Figure 5-i

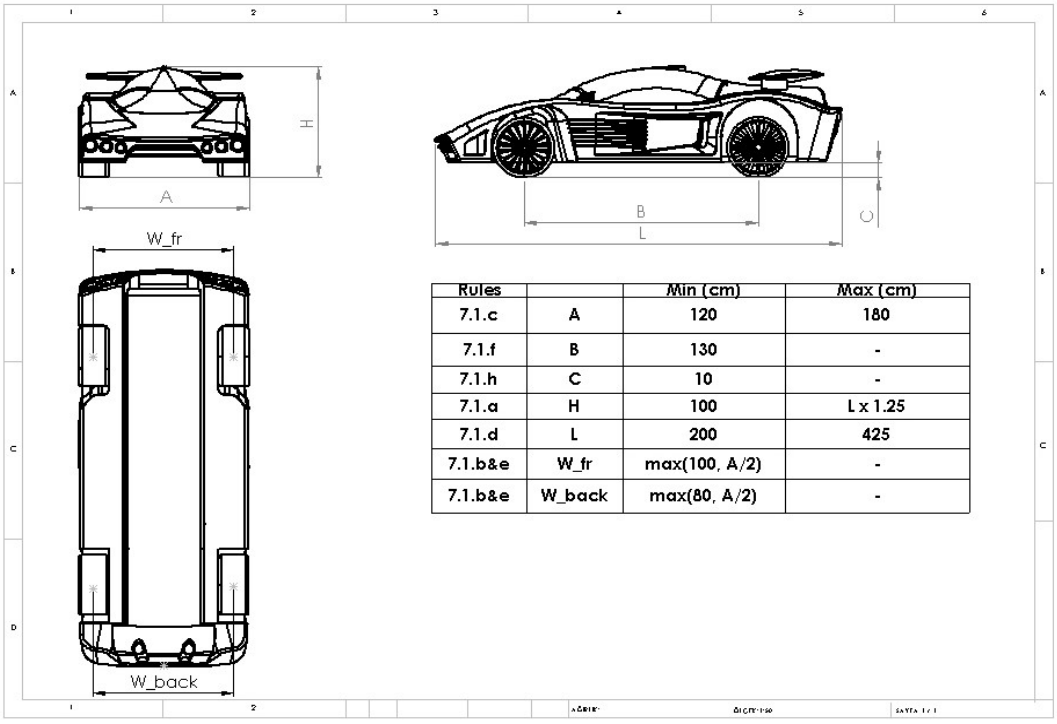
Use of aluminium sigma profiles as seen in Figure 5-i is not allowed according to the rules.

Figure 5-j

Roll bars and roll cages as in Figure 5-j should be in accordance with the defined minimum thickness measurements.

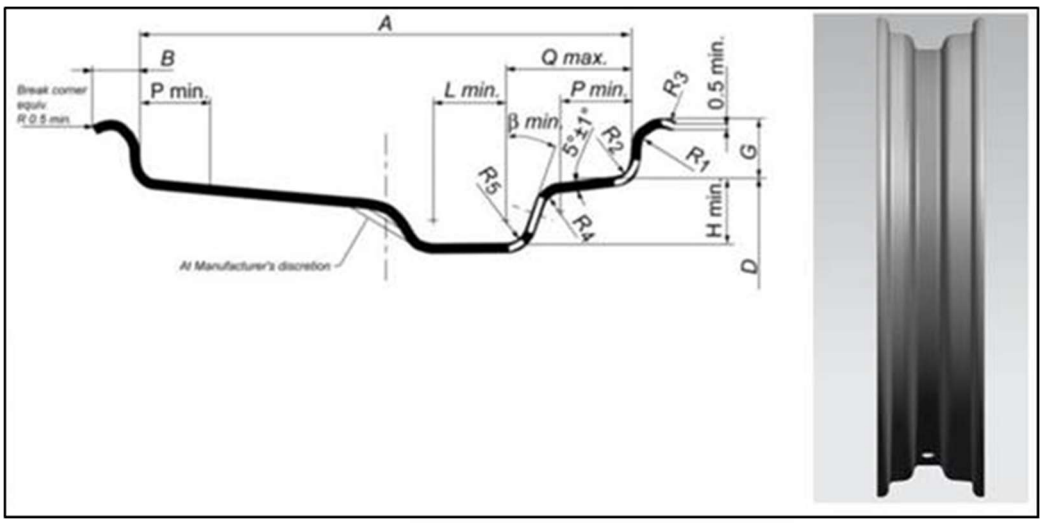
Figure 5-k

The Toyota electric vehicle shown as an example in Figure 5-k is in compliance with the rules in terms of number of seats, shape of seats, and width of door.



Rules		Min (cm)	Max (cm)
7.1.c	A	120	180
7.1.f	B	130	-
7.1.h	C	10	-
7.1.a	H	100	L x 1.25
7.1.d	L	200	425
7.1.b&e	W_fr	max(100, A/2)	-
7.1.b&e	W_back	max(80, A/2)	-

Figure 5-l. Vehicle dimensions



Şekil 5-m. Rim Contour Dimensions

Figure 6. Sample race driver seats

Figure 7-a. Suitable door lock mechanisms

Figure 7-b. Unsuitable door lock mechanisms

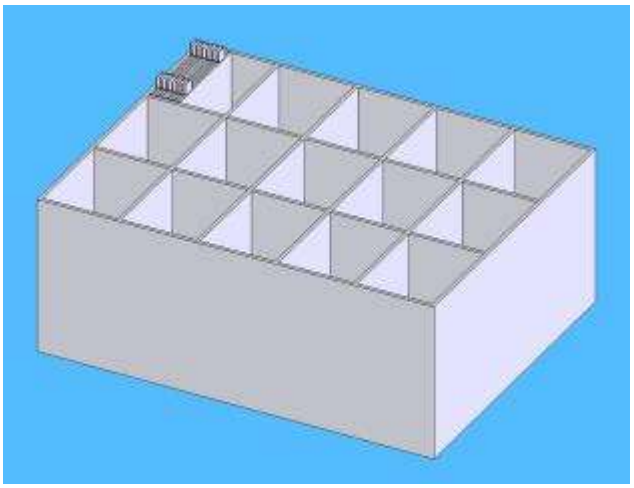


Figure 8-a. Sample drawing for battery box

Figure 8-b. Sample BMS for lithium-based batteries

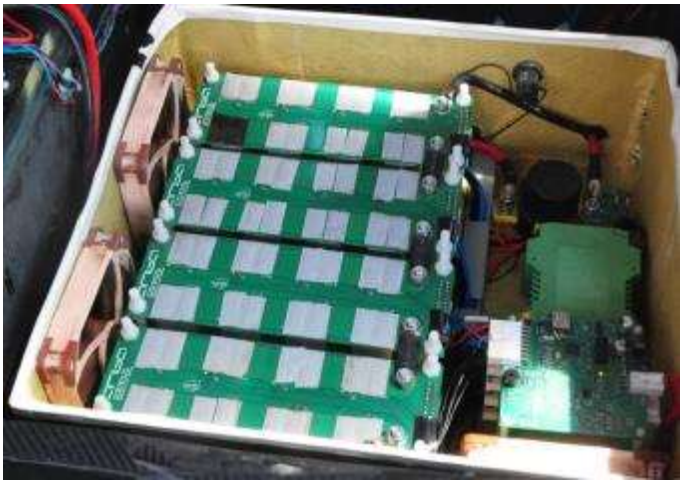


Figure 8-c. Box and sample BMS for lithium-based batteries

Figure 8. Battery box and BMS

Şekil 9. Embedded Recharging Unit

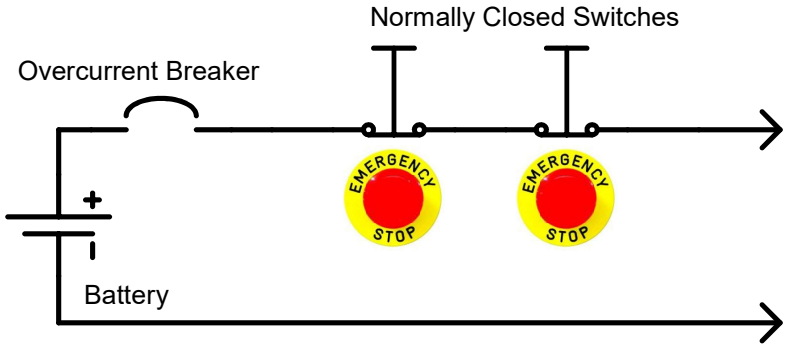


Figure 10-a. Sample breaker circuit with high-current emergency stop switch

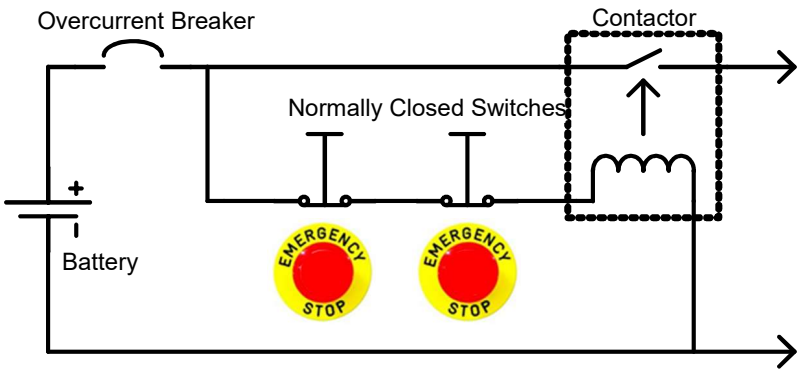


Figure 10-b. Sample breaker circuit with low-current emergency stop switch

Figure 10-c. Emergency stop button examples

Figure 10. Emergency stop switch

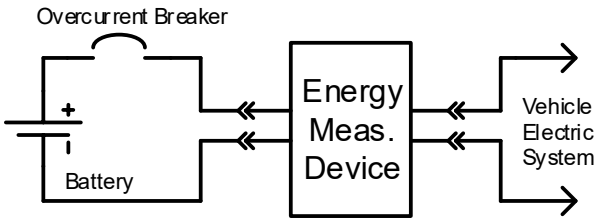


Figure 11-a. The device connection to the vehicle electric system

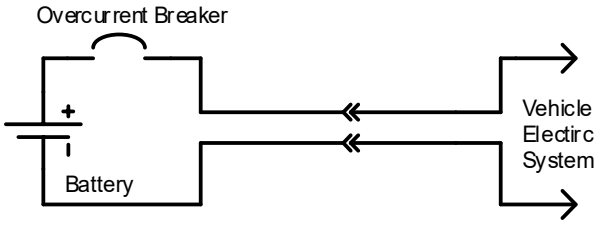


Figure 11-b. Connection when the device is removed

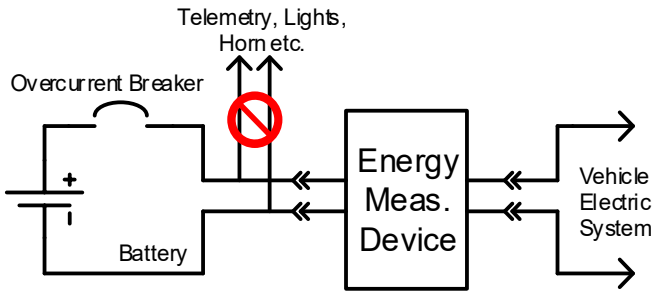


Figure 11-c. Unacceptable connection

Figure 11. Energy consumption measuring device connection

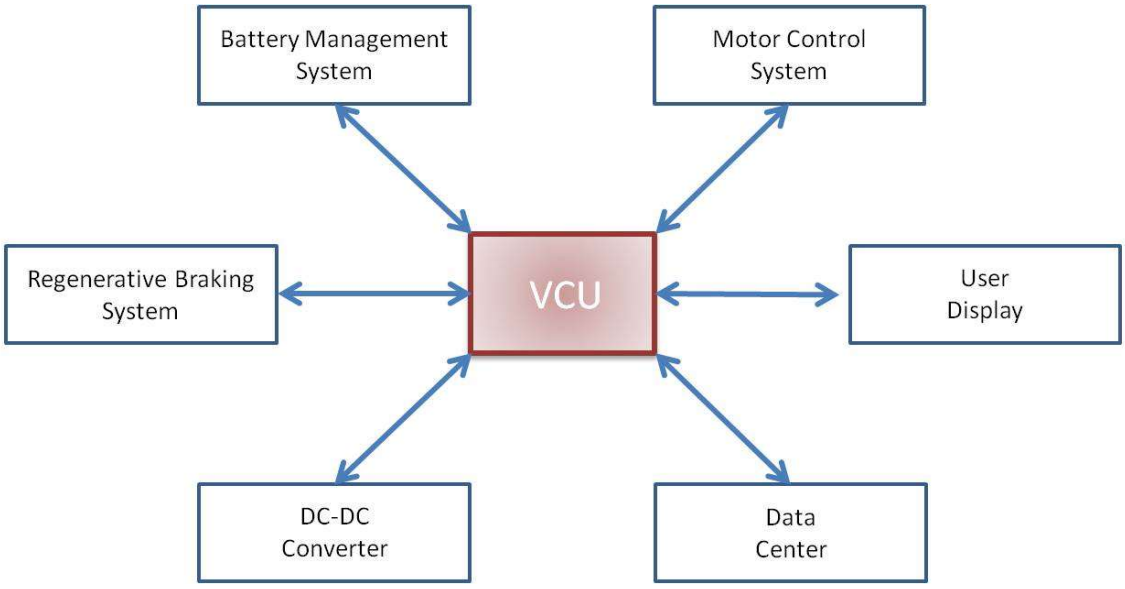


Figure 12. Vehicle control unit

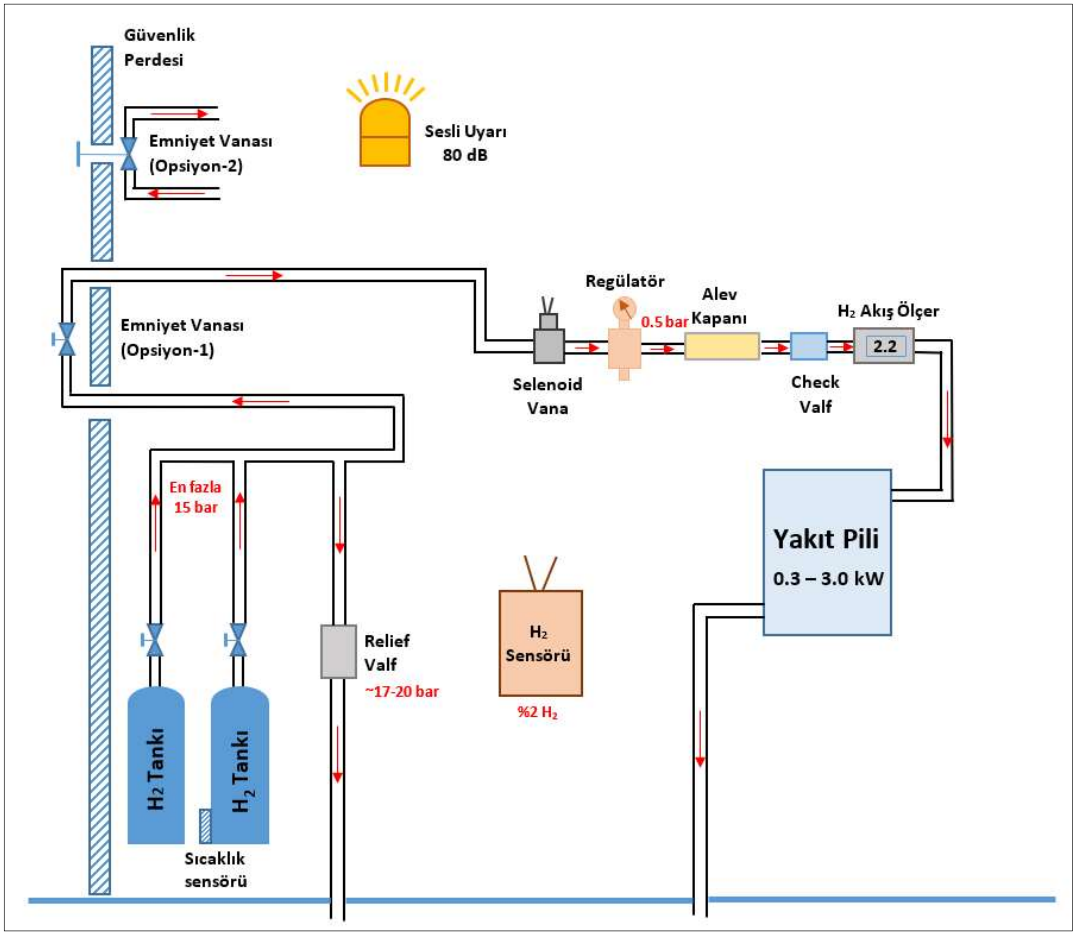
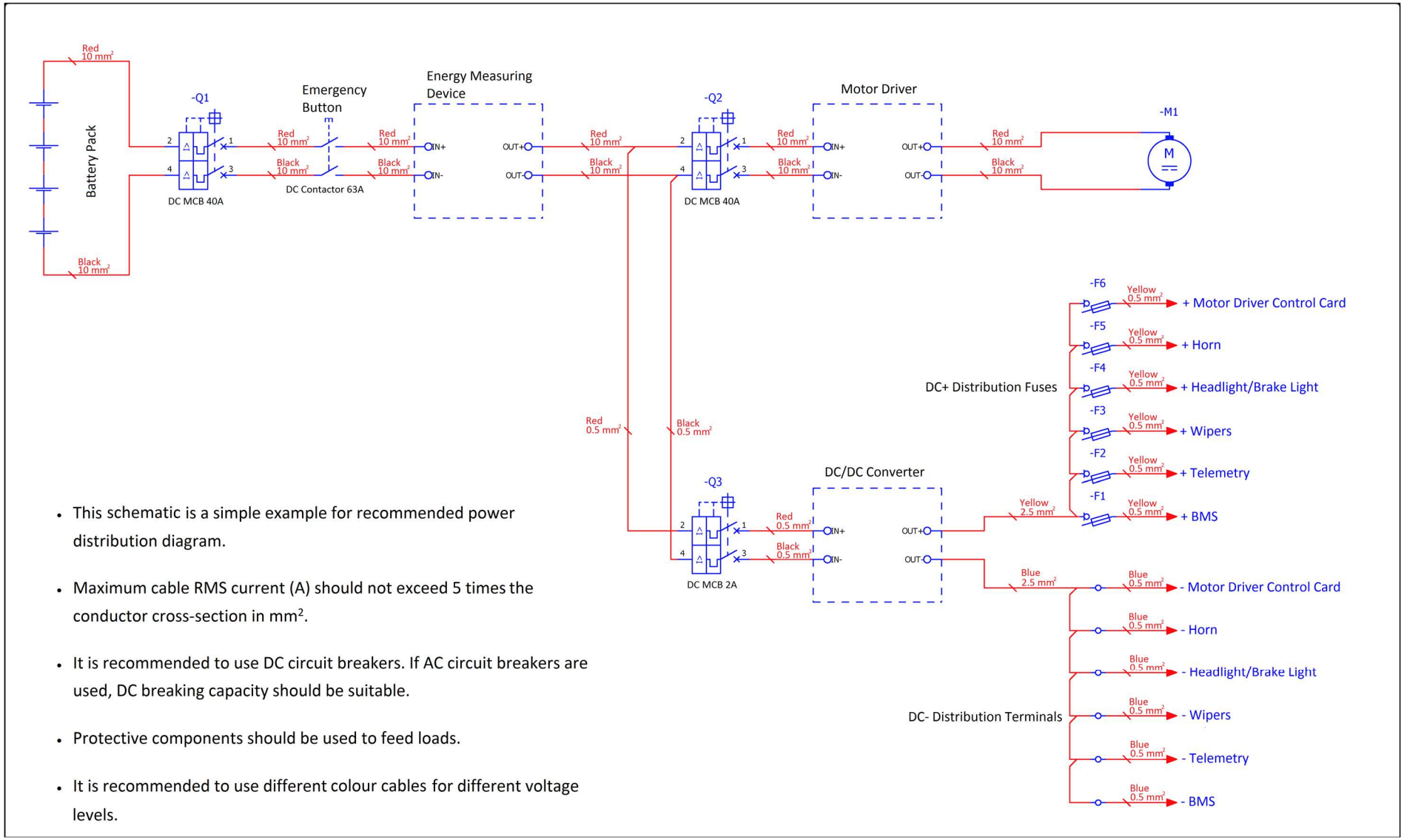


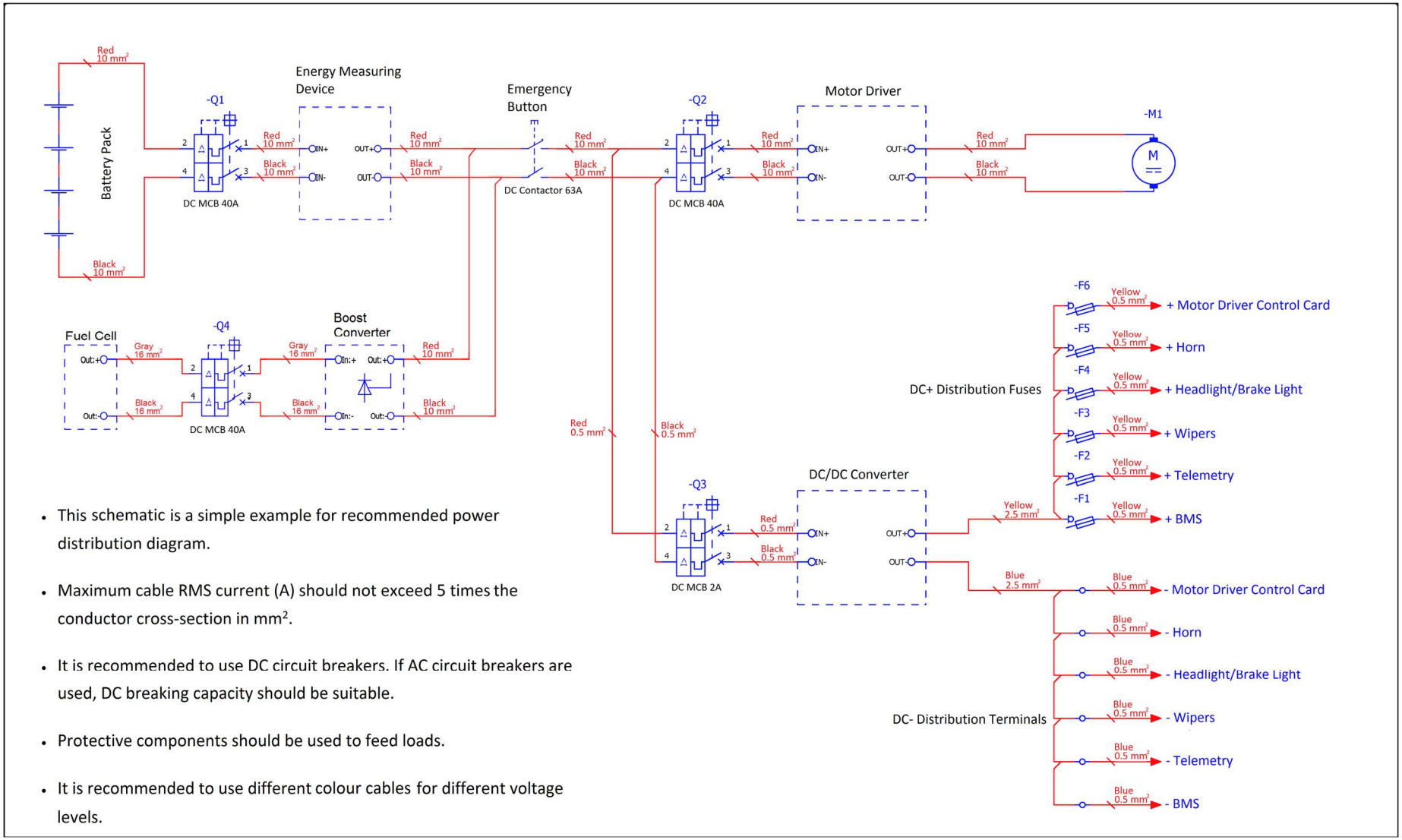
Figure 13. An example of a flow diagram in Hydromobile Vehicles

Figure 14. Examples of materials that can be used in Hydromobile vehicles



- This schematic is a simple example for recommended power distribution diagram.
- Maximum cable RMS current (A) should not exceed 5 times the conductor cross-section in mm².
- It is recommended to use DC circuit breakers. If AC circuit breakers are used, DC breaking capacity should be suitable.
- Protective components should be used to feed loads.
- It is recommended to use different colour cables for different voltage levels.

Figure 15-a. Sample distribution diagram (Electromobile)



- This schematic is a simple example for recommended power distribution diagram.
- Maximum cable RMS current (A) should not exceed 5 times the conductor cross-section in mm².
- It is recommended to use DC circuit breakers. If AC circuit breakers are used, DC breaking capacity should be suitable.
- Protective components should be used to feed loads.
- It is recommended to use different colour cables for different voltage levels.

Figure 15-b. Sample distribution diagram (Hydromobile)

Figure 16. Connection of the H_2 flow meter in the gas flow direction

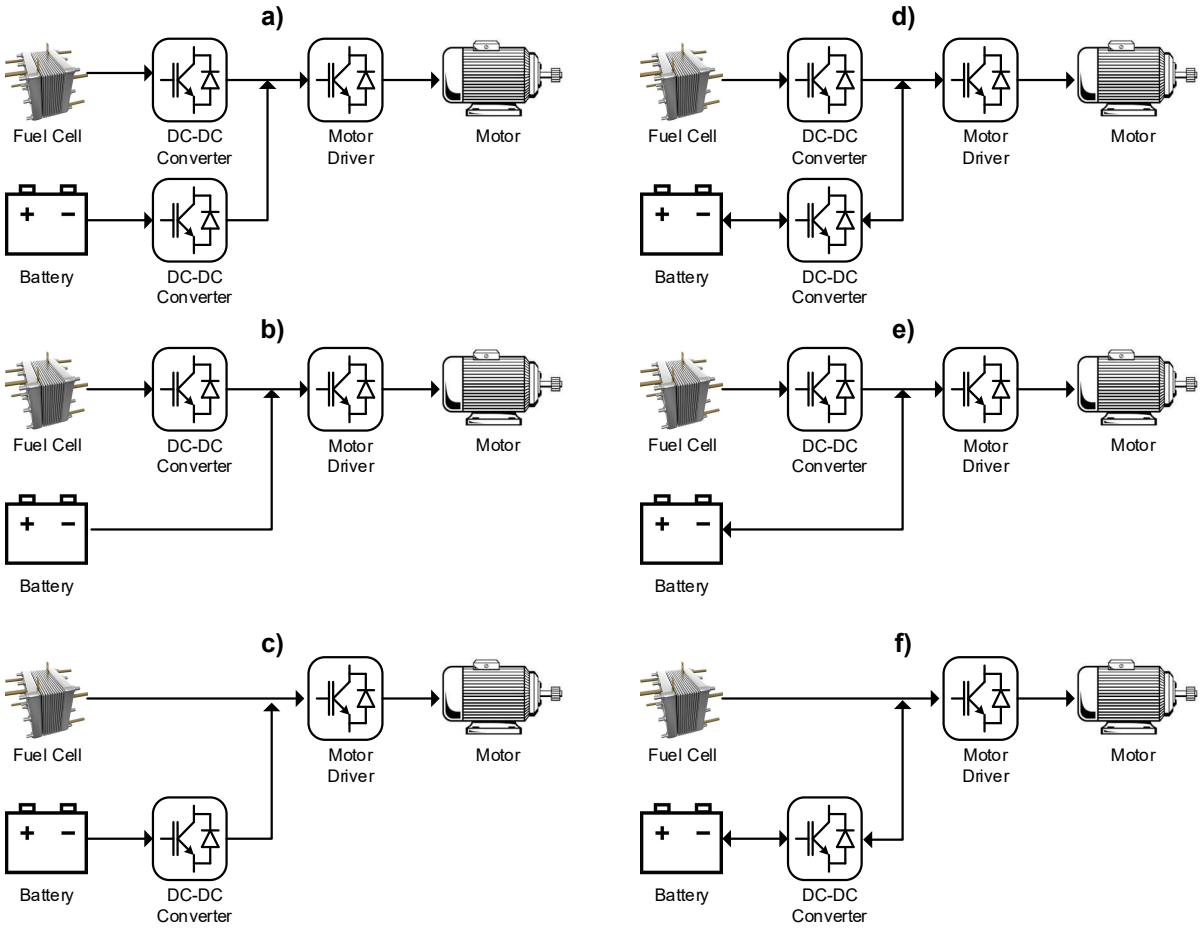


Figure 17. Possible power sources connections

Figure 18. Super Capacitor Use and Energy Measurement in Hydromobile Vehicles

Supercapacitors can be used in hydromobile vehicles to store energy released during braking and then use this energy during the acceleration process. The capacitors should not be connected to batteries or the fuel cell directly. Instead, dual-way DC-DC converters should be used between the capacitors and main DC link. To measure accurately the initial and final energy stored in the super capacitor before and after the race, the connection in Figure 18-a is recommended. In Figure 18-a, a sample supercapacitor connection diagram is given by taking one of the connection drawings in Figure 17 as an example. Super capacitor can be added to other connection schemes specified in Figure 15.

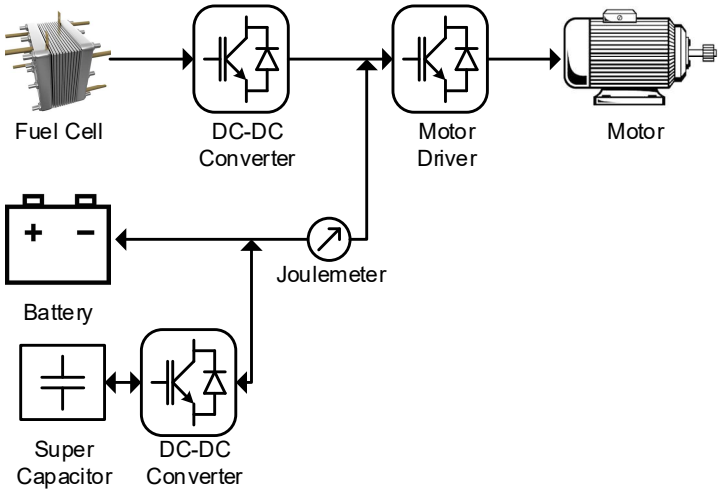


Figure 18-a

If a supercapacitor is to be connected between the energy measurement device and the motor driver for technical reasons, as shown in Figure 18-b, initial and final energy of the capacitor will be calculated by measuring the capacitor voltage, and the energy will be included in the total energy calculation. In this case, terminals should be placed at an accessible point in order to measure the capacitor voltage easily.

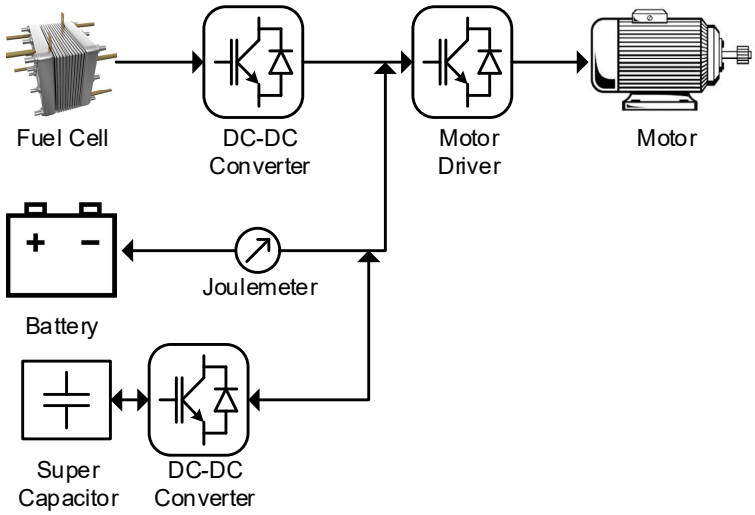


Figure 18-b

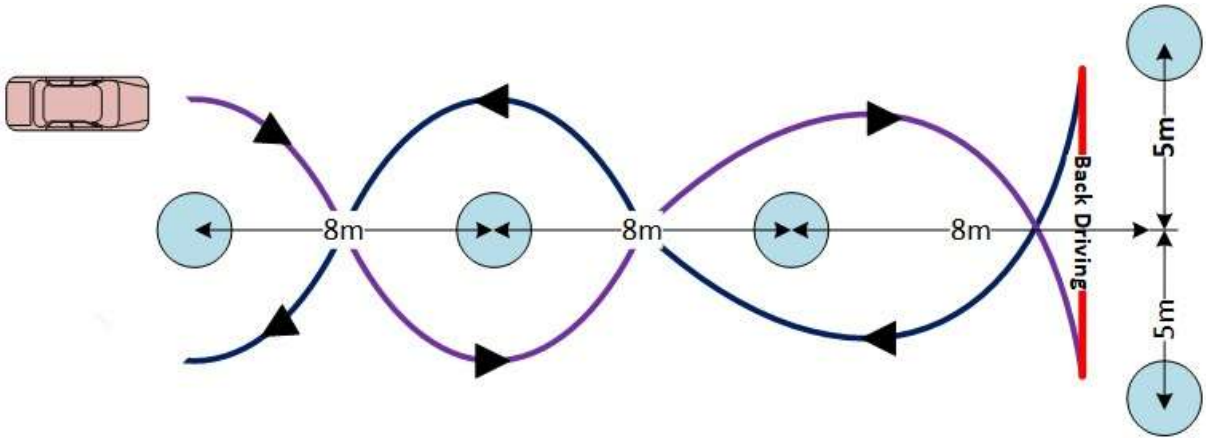


Figure 19. Dynamic testing control area measurements

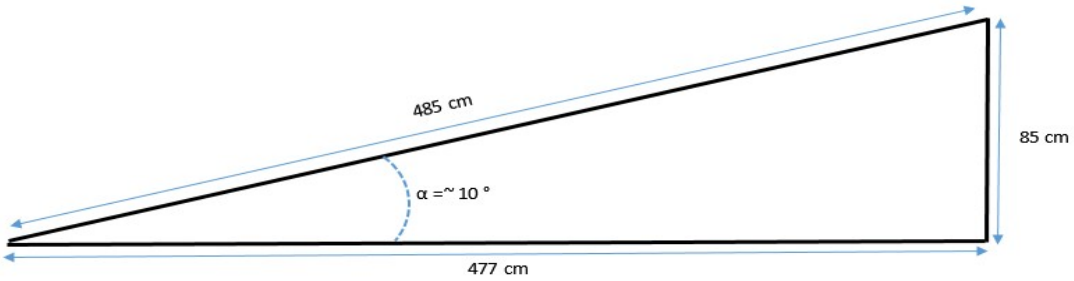


Figure 20. Dimensions of the braking platform

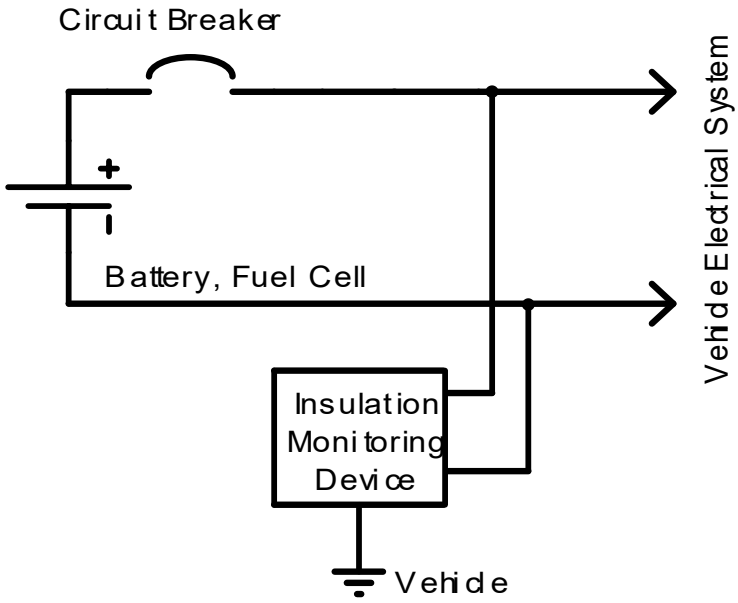


Figure 21. Insulation Monitoring Device

ANNEX 2: PENALTY LIST

		BREACHES	ELECTROMOBILE	HYDROMOBILE
DESIGN PROCESSES	Progress report	Not sending a progress report or being below the lower limit score to be determined	Disqualification	Disqualification
	Technical Design Report	The Technical Design Report is not sent or is below the lower limit score to be determined	Disqualification	Disqualification
	Domestic Production	Not having at least one mandatory local part	Disqualification due to rule violation	Disqualification due to rule violation
		For each missing mandatory subpart	30 Wh	30 Wh
VEHICLE EXTERNAL CONTROLS	Vehicle dimensions	Does not conform to the dimensions specified in the rules	2 Wh for extra each cm	2 Wh for extra each cm
		The ground clearance of the vehicle is at least 10 cm	5 Wh for extra each cm	5 Wh for extra each cm
		Vehicle height is more than 1.25 times the length of the vehicle	Disqualification due to the security reasons	Disqualification due to the security reasons
		Wheel span is less than half the width of the vehicle	Disqualification due to the security reasons	Disqualification due to the security reasons
	Vehicle body	Open place with a bird's eye view, wheels outside the vehicle	Disqualification due to the security reasons	Disqualification due to the security reasons
		Fragile glass / sharp corners / dangerous protrusions and similar problems	Disqualification due to the security reasons	Disqualification due to the security reasons
		No cover on the front / back of the shell to access the battery	Disqualification due to the security reasons	Disqualification due to the security reasons
		No cover on the front / back of the shell for access to other parts	10 Wh	10 Wh
	Vehicle Doors and their mechanisms	50x80 cm frame cannot pass	Disqualification due to the security reasons	Disqualification due to the security reasons
		Vehicle overturning or leaning on its side, preventing the driver from leaving the vehicle	Disqualification due to the security reasons	Disqualification due to the security reasons
		Does not comply with the dimensions specified in the rules	Disqualification due to the security reasons	Disqualification due to the security reasons
		The door cannot be closed without using the handle, but it is safe	2 Wh	2 Wh
		The door cannot be opened from the inside,	Disqualification due to the security reasons	Disqualification due to the security reasons

		BREACHES	ELECTROMOBILE	HYDROMOBILE
		there is a risk of opening during the race		
		The door cannot be closed without using the handle, but it is safe	1 Wh	1 Wh
		The door cannot be opened from the outside, there is a risk of opening during the race	Disqualification due to the security reasons	Disqualification due to the security reasons
	Vehicle rear view mirrors	Non / only one	Disqualification due to the security reasons	Disqualification due to the security reasons
		Areas less than 50 cm^2	Disqualification due to the security reasons	Disqualification due to the security reasons
		The driver did not see the text on the paper shown	Disqualification due to the security reasons	Disqualification due to the security reasons
	Vehicle towing hook	Non towing hook	Disqualification due to the security reasons	Disqualification due to the security reasons
		Inner diameter less than 20 mm / Not steel	Disqualification due to the security reasons	Disqualification due to the security reasons
	Vehicle taillight	Non/Cannot be seen from 25 m	Disqualification due to the security reasons	Disqualification due to the security reasons
	Vehicle headlights	Non	10 Wh	10 Wh
		Cannot be seen from 25 m	5 Wh	5 Wh
	Vehicle windshield	The material is unsuitable / not transparent	Disqualification due to the security reasons	Disqualification due to the security reasons
	Windscreen wiper	Non	10 Wh	10 Wh
		Found but not working properly	5 Wh	5 Wh
	Vehicle tire	Using tires other than tires provided by TÜBİTAK	Disqualification due to rule violation	Disqualification due to rule violation
	Flag	Smaller than 20 x 30 cm or not suitable to be attached to the vehicle	Disqualification due to rule violation	Disqualification due to rule violation
VEHICLE INTERNAL CONTROLS	Cockpit	Not enough space / unsafe for the driver	Disqualification due to the security reasons	Disqualification due to the security reasons
	Safety belt	Not fixed at 4 or 5 points or does not comply with FIA rules	Disqualification due to the security reasons	Disqualification due to the security reasons
		No passenger seat belts / Not meet with FIA regulations	5 Wh	5 Wh
	Roll bars	Missing roll bar	Disqualification due to the security reasons	Disqualification due to the security reasons
	Roll cage	Tensile strength less than 200 MPa	Disqualification due to the security reasons	Disqualification due to the security reasons
		Roll bar not perpendicular to vehicle floor	Disqualification due to the security reasons	Disqualification due to the security reasons
		Front roll bar does not start at least 3cm above the steering wheel	Disqualification due to the security reasons	Disqualification due to the security reasons

		BREACHES	ELECTROMOBILE	HYDROMOBILE
		Rear roll bar does not start at least 5 cm above helmet level	Disqualification due to the security reasons	Disqualification due to the security reasons
		Profile does not follow the rules	Disqualification due to the security reasons	Disqualification due to the security reasons
		Roll cage is not body independent and not secure	Disqualification due to the security reasons	Disqualification due to the security reasons
		Roll cage is not body independent and but secure	10 Wh	10 Wh
		Welding or bolt not fixed properly	Disqualification due to the security reasons	Disqualification due to the security reasons
	Fire extinguisher	Less than 2 kg	Disqualification due to the security reasons	Disqualification due to the security reasons
	Seat	Angle to vertical more than 30 °	Disqualification due to the security reasons	Disqualification due to the security reasons
		Bir There is a seat, but no passenger seat	Disqualification due to the security reasons	Disqualification due to the security reasons
		Not have FIA standards, not safe	Disqualification due to the security reasons	Disqualification due to the security reasons
		Not have FIA standards, but safe	5 Wh / seat	5 Wh / seat
	Steering wheel	Open form	Disqualification due to the security reasons	Disqualification due to the security reasons
	Horn	Not play for 3 seconds	Disqualification due to the security reasons	Disqualification due to the security reasons
	Speedometer	Non / not working	Disqualification due to the security reasons	Disqualification due to the security reasons
		Telemetry cannot be controlled from computer	15 Wh	15 Wh
SECURITY CONTROLS	Helmet, Racing Suit, Gloves and Shoes	Unsuitable due the rules	Disqualification due to the security reasons	Disqualification due to the security reasons
		Not FIA standards, but safe	5 Wh	5 Wh
	Brake test	Not enough	Disqualification due to the security reasons	Disqualification due to the security reasons
	Brake system	Multi circuit or not hydraulic	Disqualification due to the security reasons	Disqualification due to the security reasons
	Electrical cable connections	There is an exposed connection without insulation	Disqualification due to the security reasons	Disqualification due to the security reasons
	Emergency stop button	Non / not working	Disqualification due to the security reasons	Disqualification due to the security reasons
	Overcurrent circuit breaker	Non / Improper Design	Disqualification due to the security reasons	Disqualification due to the security reasons
	Battery	Non	Disqualification due to rule violation	Disqualification due to the security reasons
	Battery management system	Non	Disqualification due to the security reasons	Disqualification due to the security reasons
	Battery temperature measurement	No flasher and temperature indicator	Disqualification due to the security reasons	Disqualification due to the security reasons

		BREACHES	ELECTROMOBILE	HYDROMOBILE
	Battery box	Non / unsuitable design & materials	Disqualification due to the security reasons	Disqualification due to the security reasons
	Battery box fixing	Unfixed	Disqualification due to the security reasons	Disqualification due to the security reasons
		Screws thinner than 8 mm used		
	Safety curtain	No safety curtain between driver's seat and battery pack	Disqualification due to the security reasons	Disqualification due to the security reasons
	Energy meter connection	Has an external battery supply	(Battery capacity) / number of laps Wh	((Battery capacity) / number of laps Wh
	Energy meter	Battery voltage levels are beyond energy meter capacity	Disqualification due to rule violation	Disqualification due to rule violation
	Built-in charge unit	There is no electrical isolation between the grid and the battery group	Disqualification due to the security reasons	Disqualification due to the security reasons
	Telemetry	Non / unsuitable	Disqualification due to rule violation	Disqualification due to rule violation
	Fuel cell	Non/not working/greater than 3 kW		Disqualification due to the security reasons
	Super capacitor	Greater than 110 kJ		Disqualification due to the security reasons
	Pressure relief valve	Non / unsuitable		(Batarya kapasitesi kadar)/Attığı tur sayısı Wh
	Gas outlet safety valve	Non / unsuitable		Disqualification due to rule violation
	Thermocouple	Non / unsuitable		Disqualification due to the security reasons
	Flasher	Non / unsuitable		Disqualification due to rule violation
	Temperature indicator	Not connected with flasher		Disqualification due to rule violation
		Not working/low sound level		
	Metal hydride rollers	Inside the cockpit / unsuitable		Disqualification due to rule violation
		No protection shield		
		Unsafe conneciton		
	Hydrogen line	Inside the cockpit / unsuitable		Disqualification due to the security reasons
		Unsuitable design		
	Ball valve	Non / unsuitable		Disqualification due to the security reasons
		Unsuitable materials		
	Hydrogen sensor	Non / unsuitable		Disqualification due to rule violation

		BREACHES	ELECTROMOBILE	HYDROMOBILE
	Emergency evacuation (driver and backup driver)	More than 10 sec / Help needed	Disqualification due to the security reasons	Disqualification due to the security reasons

19. DEFINITIONS

- **Advisor:** Academic person who advises the team within the scope of the competition or person who with knowledge and experience about electric vehicle,

- **Application Documents:** The documents that are presented to the Scientific and Technological Research Council of Turkey (TÜBİTAK) in the specified format and content, and within the dates that have been announced.

- **Jury:** The Advisory and Assessment Committee was established by TÜBİTAK to benefit from the opinions of its members and to execute the International Efficiency Challenge Electric Vehicle.
- **Announcement:** Announcement text that defines the activity topic, scope, application conditions, support amounts, competition calendar, and special issues determined by TÜBİTAK.
- **Directorate:** The Activities Directorate where the International Efficiency Challenge Electric Vehicle is conducted,
- **Team:** The group consisting of the team captain, assistant captain, and other team members,
- **Team Captain:** The person who is determined by the team and who is responsible for communication with TÜBİTAK, who will take responsibility for the administrative and financial issues of the team, and who is obliged to be in the competition area during the registration and technical controls during the competition week,

- **TÜBİTAK:** The Scientific and Technological Research Council of Turkey.

20. RELATED LEGISLATION

- Regulation on Programs to be carried out by TÜBİTAK Science and Society Division,

- Administrative and Financial Principles to be Applied in TÜBİTAK Science and Society Projects,
- TÜBİTAK Science and Society Presidency Working Procedures and Principles,

- Directive on Activities to be carried out by TÜBITAK Science and Society Presidency,
- In cases where there are no provisions in the relevant legislation, the decisions of the Advisory and Assessment Committee and the Division are applied.

21. CONTACT

- Application and report upload: https://kys.turkiyeteknolojitakimi.org/tr/
- Invoice Entry and Support Return: https://bilimtoplum-pbs.tubitak.gov.tr/
- Announcements and Information: www.teknofest.org
- Questions: challenge@ tubitak.gov.tr / www.teknofest.org