



FS4A 2025 – Session 6

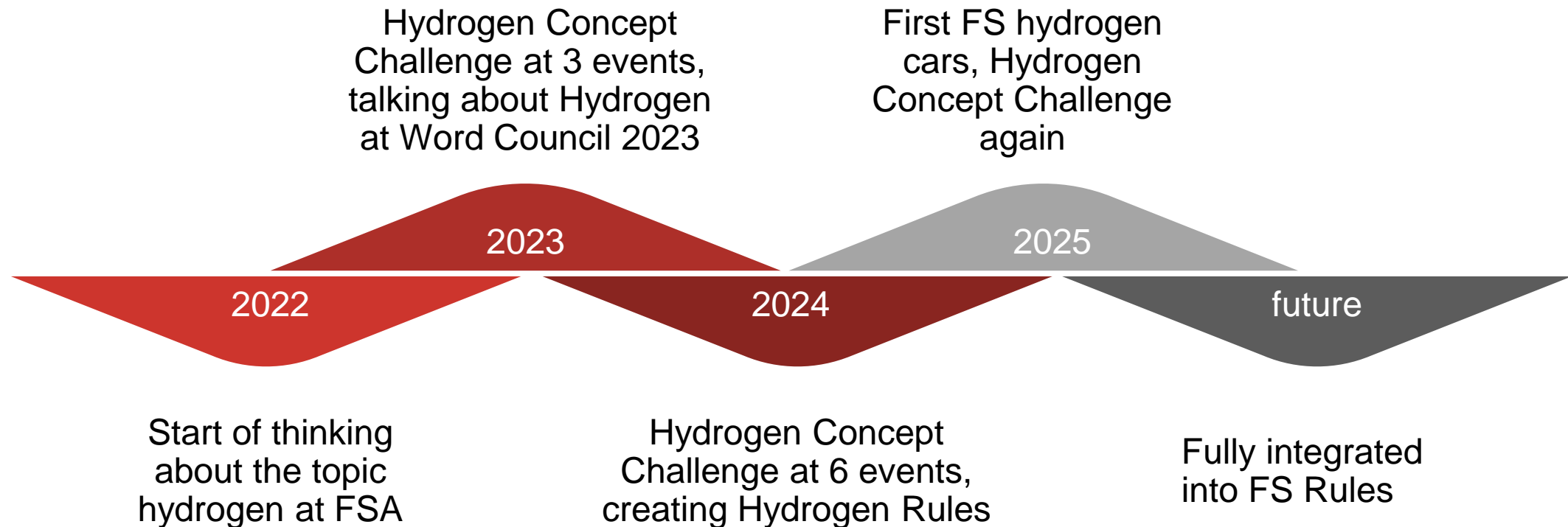
Room 1: Hydrogen Rules & Open Discussion



Presented by
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FSA Scrutineering / SES / ESF



Hydrogen Overall Status



Motivation

- Promotion of alternative technologies – generally needed in future
- Option to build a “green” car without a HV system
- Possibility for a zero emission vehicle
- Encourage students to acquire knowledge in the field of hydrogen and fuel cells
- take the next step to take FS into the future

Hydrogen Concept Challenge

- ▶ Special award (with prize money) to prepare you to develop a hydrogen car and bring you in touch with the topic
- ▶ Two documents published at the websites from the events at the middle of October:



Hydrogen Concept Challenge 2025

EV Powertrain Concept Contest

version1.0 October 17th, 2024



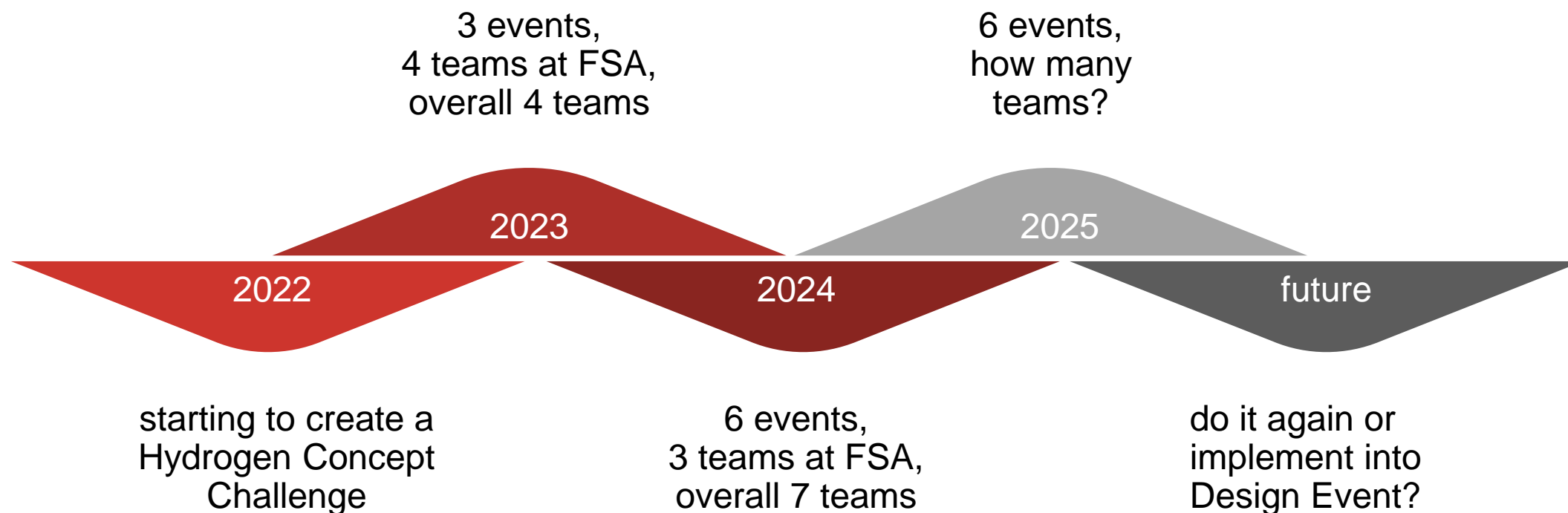
Hydrogen Concept Challenge 2025

CV Powertrain Concept Contest

version 1.0 October 17th, 2024



Hydrogen Concept Challenge Status



Powertrain Options for Formula Future

also: Austria, FSEast, Alpe-Adria, Portugal & France

Abbreviation	Description	Ruleset	Class
EV	(Battery-) Electric Vehicle	FS Rules	EV
FCEV	Hydrogen Fuel-Cell Electric Vehicle	FS Rules + Hydrogen Rules	
CV	Internal Combustion Engine Vehicle	FS Rules	CV
HY	Combustion Hybrid Vehicle	FS Rules	
H2CV	Hydrogen Combustion Vehicle	FS Rules + Hydrogen Rules	
H2HY	Hydrogen Combustion Hybrid Vehicle	FS Rules + Hydrogen Rules	

Hydrogen as a Fuel

it's not more dangerous, just different

- Hydrogen is not „explosive“ – it just burns really well
 - Hydrogen is the least dense gas, 14 times lighter than air
 - Outside: low risk, worst case is a straight-up jet of flame (flame is almost invisible!)
 - Inside: better to have no Hydrogen at all
 - Low density requires high pressures = new risks
 - still higher tank size: 12 liters H₂ @350 bar = 1 liter of petrol
- Whole Hydrogen Rules is centered around these basic facts

Hydrogen for Combustion Vehicles

- Basic engine concept stays the same (port fuel injection)
- Burning speed at $\Lambda = 1$ is 10 times higher („knocking“)
 - $\Lambda > 2$ necessary to get it under control
 - Larger engine size necessary (H2 Rules: up to 1600cc)
 - Forced induction and water injection for high power output
- H₂ & Oxygen is very easy to ignite, some metals are catalysts (Platin)
 - Backfires into the intake need to be addresses

Hydrogen for Fuel-Cell Electric Vehicles

- Maximum Hydrogen quantity: 2kg (up for debate)
- Maximum tractive system power: 100kW (instead of 80)
- Endurance: at least 50% of the energy from the fuel cell

Hydrogen Safety Officers

- Similar to ESO qualification
- We will organise a training event:

Saturday, February 22nd, 2025

Karlsruhe (KIT)

Approx. €100 per person

Interested? PRE-register now!

<https://forms.gle/Btpfq28XQoNAJiMVA>



General boundary conditions

- ▶ Only gaseous hydrogen, Cryogenic / liquid hydrogen prohibited
- ▶ All high-pressure components must be currently certified and may not be modified or used outside the manufacturer's specifications
- ▶ Maximum fuel tank pressure of 350 bar
- ▶ All parts of the H₂ system and the hydrogen tanks are considered critical components
- ▶ Structural Side Pod allowed
- ▶ Additional Sensors in Shut Down Circuit

Hydrogen Rules 2025 Version 1.0

- ▶ Check the event websites
- ▶ Version 1.0 published at 3. October
- ▶ provide a basis for discussion
- ▶ Version 1.1 will be published with your feedback in December

The screenshot shows the Formula Student Austria website. At the top left is the FSA logo with the text 'Formula Student Austria'. To the right are social media icons for Facebook, Instagram, Twitter, and RSS. Below the logo is a navigation bar with links: Welcome, FSA 2025, Visitors, Jobs, Partners, Media, Archive, and Press. The main content area features the EDAG logo and the headline 'Hydrogen Rules & Concept Challenge 2025' dated 3. October 2024. The text below the headline states: 'After two editions of the "Hydrogen Concept Challenge", we will now allow Hydrogen cars for the first time at the 2025 competition! There will be three slots reserved for cars powered by Hydrogen, either by Fuel Cell (competing together with the normal EV class) or Hydrogen Combustion (competing together with normal CV and Hybrid cars). Note: Hydrogen-Combustion can be combined with Hybrid'. A link for 'Hydrogen Rules 2025 Version 1.0' is provided. Further text mentions incentives and a feedback deadline of November 16th. At the bottom of the screenshot, the Audi logo is visible, along with logos for FS4A and LPE DRIA.

Hydrogen Rules 2025 Version 1.1

- ▶ Teams are welcome to give feedback and submit it until the 30th of November 2024 by email to: hydrogen@fs-world.org
- ▶ In order to give an indication of where changes are most likely to be made, these rules are labeled:

TBD= to be discussed. In some cases, comments are written for you in red.

Hydrogen cars at FSA

- ▶ There are 3 slots reserved for hydrogen vehicles, you have to submit a Hydrogen application before the quiz
- ▶ You have to take place in the quiz as every other team too

Hydrogen cars at FSA

- ▶ No hydrogen in buildings or outside precisely defined areas
- ▶ Teams may only work on the vehicles if they have been certified hydrogen-free by officials
- ▶ All hydrogen systems are tested with helium before any hydrogen is added
- ▶ Hydrogen tanks are always removed from the vehicles immediately after driving and the rest of the system is flushed
- ▶ Hydrogen tanks are only stored in a specified area

Scrutineering Procedure H2 CV

- ▶ Pre-Scrutineering as usual
- ▶ Mechanical-Scrutineering as usual (without hydrogen tank)
- ▶ Tilt Test (with dummy of the hydrogen tank)
 - provided by the team
 - same mass and cg
- ▶ Hydrogen Scrutineering, only after this the H2 the tank may be installed
- ▶ Noise Test
- ▶ Brake Test

Scrutineering Procedure H2 EV

- ▶ Pre-Scrutineering as usual
- ▶ Accu-Scrutineering and Electrical Scrutineering as usual
- ▶ Mechanical-Scrutineering as usual (without hydrogen tank)
- ▶ Tilt Test (with dummy of the hydrogen tank)
- ▶ Hydrogen Scrutineering, only after this the H2 the tank may be installed
- ▶ Raintest with running fuel cell
- ▶ Brake Test

Hydrogen Scrutineering

- ▶ Check certificate of Hydrogen Safety Officers (HSOs)
- ▶ Check Hydrogen System Form (H2SF)
- ▶ Testing of hydrogen-specific components such as tanks, pressure regulators, quick-release, valves, pipes and hoses, fittings,... and their data sheets

also check out the next page

Hydrogen System leak test

▶ Helium

- Flush the system with helium from the tank connection until no O₂ can be measured at the farthest most end of the H₂ system
- Then bring to nominal pressure and check with helium detector.
- mark all tested H₂ components and connections

▶ H₂

- Fill system with H₂ from external bottle to nominal pressure
- “sniff” all H₂ components and connections
- seal sticker all tested H₂ components and connections
- Flush the system with helium from the tank connection and shut in approx 0,5 to 1 bar

▶ Sign on the mainhoop “H₂ system discharged and inert”

Training Hydrogen Safety Officer

- ▶ FSA is organizing with the company Lifte H2 as training for Hydrogen Safety Officers (HSO)
- ▶ Take place in Karlsruhe at 22nd February 2025
- ▶ due to the severity of the topic likely only in German
- ▶ Costs up to 100€ per team member, getting a certificate
- ▶ Each hydrogen team needs 2 to 4 HSO

Bringing the car to “H2-hot” 1 of 2

- ▶ Team arrives at SHyTTA with vehicle
- ▶ Official checks the seals and whether there is still overpressure with helium in the system
- ▶ Break the tank connection seal
- ▶ HSO and max.1 helper install the tank under supervision
- ▶ Close valve after pressure regulator, open tank valve.
- ▶ Official checks for leaks in the H2 system with H2 detector

Bringing the car to “H2-hot” 2 of 2

- ▶ The system is slowly filled with H2 from the tank to farthest most end of the H2 system. Test with H2 detector
- ▶ The vehicle is now confirmed, leak free and 100% filled with H2
- ▶ Tank valve closed
- ▶ Sign on the main hoop “H2 system HOT”
- ▶ Vehicle is pushed to dynamic, test area or engine test while being escorted by an official

Bringing the car to safe status

“H2 system discharged and inert” status

Carry out the work steps from the previous pages in a different sequence. At the end, attach the sign “H2 system discharged and inert” to the main hoop. Team can take the vehicle with them.

Working on the H2 System after Scruti

only without H2 tank

- ▶ Let us know
- ▶ get permission
- ▶ Breaking seals
- ▶ come back for the 'H2 leakage test'

ONLY in that order!! ;-)

Open points for events 24/25



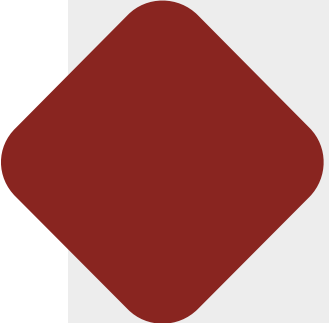
H2SF

creating a Hydrogen System Form (HSF) similar to HSF mixed with SES and IAD



Hydrogen Rules


update Hydrogen Rules with feedback from you and companies



Hydrogen refuelling


finding company/ sponsor for Infrastructure for hydrogen refuelling

Teams´ s biggest challenges



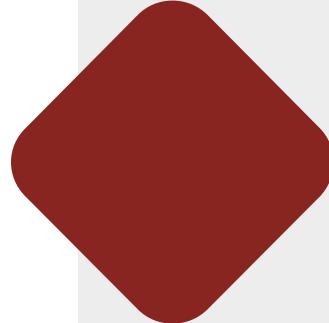
suitable H2 parts

finding sponsors and suppliers for hydrogen components like tanks, valves and fuel cell



Handling H2 by the teams

Refueling for testing, working and test H2 drivetrain at the university



Transport H2 car to the events

Legal regulations on load securing and transport of hazardous goods

Open points for events 25/26



Standard parts

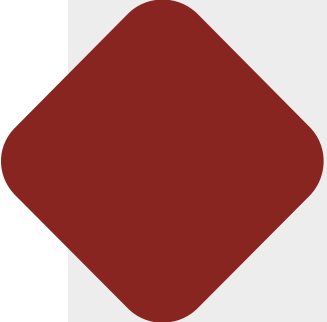
Having standard parts to save costs:

- Hydrogen tank
- On tank valve (OTV)
- Fuel cell



Hydrogen Rules

update Hydrogen Rules with feedback from you and companies



Standard for refuelling

standardisation interface between tank and filling station



Q&A Session

The text 'FS4A' is displayed in a bold, white, sans-serif font. The '4' is colored red, while 'FS' and 'A' are white. The text is centered on a black, horizontal brushstroke background that has a rough, textured edge.

If you have further questions,
please write us at Hydrogen@fs-world.org



Q&A for Session 6

Question	Answer
Will the quiz be the same as the class we compete or are we having our own hydrogen quiz?	The quiz will be the same and everybody has to participate because the quiz results will determine the tech inspection order. For Fuel-Cell you will take the "EV" quiz, for H2CV the "CV" quiz.
Hydrogen Tank: Removable tank is a massive security flaw (I talked with two independent experts, they were both highly concerned). At some point, the coupling gets damaged. Fixed tank is way safer, is it still possible to change this rule?	A fixed tank is not possible for us because it is not approved by the event sites. Formula Student has fundamentally different requirements compared to normal automotive sector.
Does the vehicle status video also apply to hydrogen vehicles?	Yes, but at least for Fuel-Cell cars you are not required to actually use the Hydrogen, running on the battery would be okay as well.
If one team competes with one car each for EV and Hydrogen ICE, can this team present the same business plan in both presentations or does it have to be two different business plans?	No, in this case this will be treated as two completely separate Teams, just like in the past when many universities had one CV and one EV. You must not share team members and the same business model would get you massive point deductions for the BPP.