Project SHARP — Power Generation and Delivery System

Project Plan

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Change record

Issue	Date	Total pages	Page(s) affected	Description of change
1.0	02/02/2026	5	0–5	Adapt Initial Template
2.0	03/02/2026	14	0–14	Create chapters and fill in rough required elements
2.1	06/02/2026	15	4–14	Refine outline for all sections and work out chapters 1–4
2.2	09/02/2026	23	5–8, 10, 13, 14, 17–22	Created data driven Research Questions and Work Packages
2.3	10/02/2026	20	5, 6, 9, 11, 12	Adapted Work Packages and work out chapter 7
2.4	11/02/2026	23	12–16	Work out chapters 8–10

Table of Contents:

1 Background

Stellar Space Industries

Stellar Space Industries (SSI) is a Dutch aerospace company located in Noordwijk near European Space Agency (ESA)'s ESTEC facility. SSI specialises in high precision manufacturing capabilities and covers the entire product development cycle including design, machining, assembly, integration and testing. Their production facility is equipped with high-precision machining and testing equipment.

In collaboration with ESA, SSI is developing a novel electrodeless electric propulsion system for small satellites. This propulsion system aims to increase efficiency, lifespan and reliability compared to current state-of-the-art electric propulsion systems. SSI is currently in their second phase of development where they aim to design build and test the entire system in-house.

Presently, several subsystems of the propulsion system are being developed and tested concurrently. During the development of these subsystems, SSI is also looking for opportunities to apply the technology of each component in other applications. One of the subsystems that is currently ready for testing and application is SSI's Flow Control Unit (FCU) which is a high-precision valve that can control the mass flow of gaseous propellants.

Project SHARP

In order to find a relevant application for their FCU, SSI has initiated the Solid Hydrogen Aircraft Regulated Propulsion (SHARP) project. SHARP is a joint investigation between SSI and Solid Flow, a Dutch company specialising in the development of solid hydrogen storage systems. The goal of SHARP is to investigate the feasibility of hydrogen-fuelled drones that utilise solid-state hydrogen storage. In this collaboration, Solid Flow provides the cool gas generator (CGG), a system capable of producing gaseous hydrogen on demand from solid hydrogen storage. SSI contributes its expertise in flow control systems for electric propulsion, which may be adapted for hydrogen-based applications.

SHARP is conducted under the Luchtvaart in Transitie (LIT) program of the RVO of the Dutch government, which aims to advance sustainable aviation technologies. SHARP aims to contribute to the aviation energy transition by providing a scalable, weight and volume efficient energy source that is CO_2 and NO_x neutral. SHARP first aims to demonstrate the feasibility of the technology in drone applications, allowing future projects to scale the technology to larger aircraft and replace traditional jet fuel-based propulsion systems.

SHARP — Power Generation and Delivery System

This document considers the project plan for a subsystem of the SHARP project, specifically the development of the power generation and delivery system. This part of the SHARP project is conducted as a graduation internship. Throughout this document the part of SHARP that falls under the graduation internship will be referenced as SHARP — Power generation and feed System (SHARP-PS).

2 Project Results

For Stellar Space Industries, the primary goal for SHARP is to test and apply their FCU in a real world scenario and thus advance the FCU's technology readiness level (TRL) from 4 to 6. In addition to this, they aim to find a secondary market for their FCU in hydrogen based aviation compared to electric propulsion for satellites. Solid Flow has the same goals for their hydrogen CGG. The goal of SHARP-PS is to integrate the FCU and CGG and demonstrate the technologies and their compatibility in a relevant environment.

The relevant environment for the SHARP-PS project will be a fuel cell that delivers power to a motor and propeller system. Results of tests performed in this environment will be directly applicable to hydrogen based aviation projects. The result of the SHARP-PS project will be a test bench setup that includes this fuel cell and motor-propeller system and the integrated FCU and CGG hydrogen supply. This test bench setup shall be easily adaptable to be integrated into an unmanned areal vehicle (UAV). The project result of SHARP-PS shall meet the following requirements:

- Stellar Space Industries' FCU shall be included in the system.
- Solid Flow's hydrogen CGG shall be included in the system.
- A fuel cell shall be used to generate electricity from hydrogen.
- The system shall function without external power supply.
- The power density (power output over system weight) of the system must be the same or higher than that of state-off-the-art UAV power systems.
- Test results will be recorded and presented in a research report that is in accordance with 'Report writing for readers with little time' (Elling & Andeweg, 2012)
- The research report shall answer the following research question: 'To what extent is a hydrogen fuel cell based power generation and delivery system that integrates a Solid Flow's cool gas generator and Stellar Space Industries' flow control unit feasible for extending the mission time for UAV's'

The aforementioned research question will be subdivided into the following sub research questions:

RQ-1 What functional, performance, and safety requirements must the power generation and feed system meet to be integrated into a UAV?

RQ-2 What are the relevant performance characteristics of Solid Flow's cool gas generator and Stellar Space Industries' flow control system?

RQ-3 What flight-time improvement is theoretically achievable with hydrogen storage and fuel cells compared to state-of the-art UAV battery systems?

RQ-4 Which system architecture best balances safety, efficiency, weight, system complexity, and manufacturability for the power generation and feed system?

RQ-5 Which components (fuel cell, intermediate electrical storage, power electronics) are most suitable based on the system requirements and design constraints?

RQ-7 What electrical architecture ensures stable power delivery from the fuel cell system to state-of-the-art UAV propulsion systems and onboard electronics?

RQ-8 How does the integrated hydrogen-based power system perform during ground testing in terms of power output, stability, efficiency, and safety?

RQ-9 What technical risks, failure modes, or limitations affect the overall feasibility of implementing the system in operational UAV flights?

These research questions have been arranged into a research matrix where they have been assigned a research method and is specified what instruments or tools are used and what the output is of each research question. This research matrix is shown in Appendix A.

3 Project Activities

The project is divided into multiple activities. The activities are organized into categories, so that each category is of a similar level of complexity. Note that some activities are dependent on other activities. This, along with the time constraints of each activity, is discussed in section 8 Planning. Each category also resembles the activities for a work package. A list of all work packages can be found in Appendix **??**.

WP-1 Planning

1.1 Literature study on hydrogen storage and fuel cells [20]
1.2 Analysis of mission scenario and constraints [10]
1.3 Definition of functional and safety requirements [20]
1.4 Definition of test strategy and success criteria [10]
1.5 Writing and finalising the project plan [60]

WP-2 Design

2.1 Conceptual design of UAV architecture [40]
2.2 Development of multiple conceptual test bench architectures [40]
2.3 Definition of system boundaries and interfaces [20]
2.4 Trade-off analysis and concept selection [10]
2.5 Detailed mechanical and electrical design [80]
2.6 Component selection and verification against requirements [10]

WP-3 Build

3.1 Supplier selection and procurement of components [??]
3.2 Manufacturing of mechanical parts where required [40]
3.3 Assembly of mechanical, electrical, and fluidic subsystems [80]
3.4 Integration of fuel cell, storage, and power electronics [80]

WP-4 Test

4.1 Finalisation of test procedures and safety measures [20]
4.2 Execution of ground tests under controlled conditions [60]
4.3 Data logging and documentation of test results [20]
4.4 Analysis of measured data and comparison with requirements [20]

WP-5 Report

5.1 Writing progress report [10]
5.2 Finalising documentation of design, build, and test phases [10]
5.3 Submitting draft graduation report [40]
5.4 Incorporating feedback into final graduation report [20]
5.5 Writing reflection report [20]
5.6 Preparing company presentation [10]
5.7 Preparing poster presentation [10]

If time allows, the scope of the SHARP-PS project can be extended, this will be discussed in more detail in section 4 Scope. Should this scope extension indeed be the case, this will lead to additional activities.

4 Scope

As SHARP-PS is conducted as an internship, the start and end dates are fixed. The internship runs from 2 February 2026 to 14 June 2026, and as such SHARP-PS will follow those dates strictly. At this time, the exact time requirement for the SHARP-PS project can not yet be accurately determined, only estimated. Therefore, the scope of the project is made slightly flexible to satisfy the exact time requirement of the internship.

This chapter defines a minimum scope which concerns the development and testing of an independent power generation and feed system that is not yet integrated in a UAV, this setup is also referred to as a test bench setup. If time allows, integrating this power system into a commercial off-the-shelf (COTS) or custom built UAV may be included in the scope of SHARP-PS as well.

The following lists describe the scope of the SHARP-PS project and exactly which activities are part of it. This is done by listing certain activities that fall particularly at the border of the project, and clarifying whether or not they are part of SHARP-PS, the SHARP-PS extended scope, SHARP as a whole or not part of SHARP at all.

Activities that **are** included in SHARP-PS:

- Designing a system overview of the complete power generation and feed system.
- Selecting components for the hydrogen fuel cell and intermediate electrical storage
- Developing the electrical design of the power generation and feed system.
- Performing assembly and integration of the power generation and feed system.
- Conducting ground testing of the power generation and feed system using a gaseous hydrogen source.
- Compiling a comprehensive report of all findings and results.

Activities that initially **are not** included in SHARP-PS, but **may** be included in SHARP-PS if allowed by time:

- Selecting a suitable COTS or custom built UAV.
- Selecting components for the UAV interfaces.
- Implementing mechanical modifications to the UAV to ensure system compatibility.
- Integrating the power system developed as part of the test bench setup with the selected UAV.
- Conducting flight testing of the integrated power system and UAV using a CGG hydrogen source.

Activities that have already been completed by SSI (**not** part of SHARP-PS):

- Developing the flow control unit.
- Testing the FCU in lab conditions.
- Adapting the FCU for hydrogen purposes.

Activities that **are not** included in SHARP-PS but are part of the larger SHARP project:

- Designing a mission scenario for solid hydrogen based UAV's.
- Setting requirements for the hydrogen CGG.
- Producing a hydrogen CGG.

5 Deliverables

When completed, each activity stated in section 3 produces a result in the form of a deliverable. Each deliverable is a tangible result and can be seen as a milestone within the project. When all the deliverables have been delivered, the project will be complete. The activities are grouped into work packages and as such the deliverables can also be grouped to the same work packages. The complete list of the work packages is shown in Appendix B.

WP-1 Planning

- 1.1 Literature review summary
- 1.2 System requirements specification
- 1.3 Test strategy and safety considerations
- 1.4 Approved project plan

WP-2 Design

- 2.1 Selected test bench concept
- 2.2 CAD models and mechanical drawings
- 2.3 Electrical schematics
- 2.4 Bill of materials (BOM)

WP-3 Build

- 3.1 Fully assembled and integrated test bench
- 3.2 Updated BOM and cost overview
- 3.3 Assembly and integration documentation

WP-4 Test

- 4.1 Test logs and raw measurement data
- 4.2 Performance analysis results
- 4.3 Technical feasibility assessment

WP-5 Report

- 5.1 Final project report
- 5.2 Reflection report
- 5.3 Company presentation assessment by Company Supervisor
- 5.4 Poster presentation preparations

6 Quality Control

To assure the quality of the project, each deliverable has been assigned at least one review method. For deliverables of the same type, the review methods are the same. Table 1 lists the review methods that are assigned to each type of deliverable.

In addition to reviewing the quality of each deliverable, both quality and time are kept track of by weekly progress meetings with the company supervisor. This allows the company supervisor to provide feedback and advice and review the quality of the project as a whole on a weekly basis.

Deliverable Type	Review Methods	Software used
Documents	Company Supervisor review, University Supervisor review	LaTeX, MS Word
Designs	Company Supervisor review	Autodesk Inventor
Hardware	Company Supervisor review, Performance testing	—
Test results	Company Supervisor review, Comparison to expected results	MS Excel

Table 1: Quality control of deliverable types

7 Project Organisation

This chapter will describe the organisational structure that the SHARP-PS project will be conducted in. The SHARP-PS project is an internship project and as such will be carried out as an individual project by a single intern. Both the university and the company provide a supervisor that can provide support to the intern. The communication details of the intern and supervisors is listed in table 2.

Supervisor communication

There will be weekly progress meetings with the intern and the company supervisor on Thursdays at 14.00. This meeting will serve to keep the company supervisor up-to-date with the progress of the project and allow them to address concerns regarding planning or quality. In addition to this, the progress meetings serve as an opportunity for the intern to ask questions and request support from the company supervisor if necessary.

Communication between the intern and the university supervisor will happen through email.

Document location

Files regarding the SHARP-PS document will be stored in the OneDrive environment for project SHARP. This environment has been shared with the intern already. The location within this environment that is dedicated to the SHARP-PS project is the following:
'LIT-R&D-SHARP-SF-SSI — Phase A Documentation/WP3_Hydrogen_Transport_System'

Any documents that are required by the University, but are not required by the company wil be saved in the OneDrive environment for external collaboration:
'SSI External Collaboration — InHolland_Graduation_Internship_Emil/Documents'
These documents will be handed in at the university through the OnStage environment. The OnStage environment is also the leading place for listing the documents that need to be handed in and their respective deadlines.

Name	**Role**	**Email Address**
Imre Bakker	Company Supervisor	imre.bakker@stellarspaceindustries.com
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Table 2: Communication details

8 Planning

In this chapter, all the activities from the work packages in Appendix B are listed along with their estimated hour requirement. As each of the work packages have a start and end date, these activities can be organised into a Gantt chart. This Gantt chart is shown here in figure **??** and in appendix C.

WP-1	Planning	120
WP-1.1	Literature study on hydrogen storage and fuel cells	20
WP-1.2	Analysis of mission scenario and constraints	10
WP-1.3	Definition of functional and safety requirements	20
WP-1.4	Definition of test strategy and success criteria	10
WP-1.5	Writing and finalising the project plan	60
WP-2	Design	200
WP-2.1	Conceptual design of UAV architecture	40
WP-2.2	Development of multiple conceptual test bench architectures	40
WP-2.3	Definition of system boundaries and interfaces	20
WP-2.4	Trade-off analysis and concept selection	10
WP-2.5	Detailed mechanical and electrical design	80
WP-2.6	Component selection and verification against requirements	10
WP-3	Build	200
WP-3.1	Supplier selection and procurement of components	??
WP-3.2	Manufacturing of mechanical parts where required	40
WP-3.3	Assembly of mechanical, electrical, and fluidic subsystems	80
WP-3.4	Integration of fuel cell, storage, and power electronics	80
WP-4	Test	120
WP-4.1	Finalisation of test procedures and safety measures	20
WP-4.2	Execution of ground tests under controlled conditions	60
WP-4.3	Data logging and documentation of test results	20
WP-4.4	Analysis of measured data and comparison with requirements	20
WP-5	Report	120
WP-5.1	Writing progress report	10
WP-5.2	Finalising documentation of design, build, and test phases	10
WP-5.3	Submitting draft graduation report	40
WP-5.4	Incorporating feedback into final graduation report	20
WP-5.5	Writing reflection report	20
WP-5.6	Preparing company presentation	10
WP-5.7	Preparing poster presentation	10

Table 3: Work package activities with estimated hour requirement.

9 Costs and Benefits

During the SHARP-PS project, a hydrogen based power generation and delivery system will be developed that can be incorporated into a UAV. The costs of this power system will depend on the scale of the mission scenario. As of the writing of this document, the mission scenario has not yet been determined. As stated in section 4 Scope, determining this mission scenario is not part of SHARP-PS, but will instead be determined by Stellar Space Industries.

To help with choosing the scale of the mission scenario, table 4 a rough cost overview has been created that includes three different scales of available COTS drones, and the fuel cell that would be required to power them. Note that the values in table 4 are not exact values and do not represent the total cost of the project, they do however provide insight into how the scale options compare and the order of magnitude of the cost.

The COTS drones and fuel cells used for this analysis are from DJI and H2Planet respectively. (*DJI - Official Website — dji.com*, n.d.), (*H2Planet - Hydrogen & fuel-cell experience — h2planet.eu*, n.d.)

	Small	**Medium**	**Large**
Model	DJI air	DJI Inspire	DJI Matrice 400
Power	100 W	230 W	1.2 kW
Drone Weight	0.7 kg	4 kg	15 kg
Fuel Cell Weight	0.6 kg	1 kg	2–6 kg
Drone Cost	€1,000	€15,000	quote
Fuel Cell Cost	€1,500	€3,000	€12,000
Total Cost	€2,500	€18,000	$>$ €30,000

Table 4: Cost overview of three scales of drone and fuel cell combinations

10 Risks

In order to ensure the chance of success for this project is as high as possible, some of the major risks have been identified. Each risk has been assigned a level of likelihood and a level of impact. Furthermore, a mitigation strategy has been created for each risk in order to lower its likelihood, impact or both.

Risks have been separated into internal and external risks. Internal risks are managed by project members or stakeholders, while external risks are events that happen outside of the control of project members.

Risk	Likelihood	Impact	Mitigation Strategy
Schedule overrun due to redesign iterations	Medium	High	Iterative validation, design reviews, schedule buffer
Schedule delay due to failed tests	Medium	High	Incremental testing, early subsystem validation
Budget overrun due to unexpected component costs	Low	Medium	Cost monitoring, contingency budget
Underestimation of subsystem integration complexity	Medium	High	Early interface definition, integration plan
Electrical instability or control issues in power electronics	Medium	High	Simulation before implementation, staged testing
Thermal management problems in fuel cell or electronics	Medium	Medium	Thermal analysis, temperature monitoring
Hydrogen leakage in test setup	Low	High	Leak testing, gas sensors,
Overpressure in hydrogen lines	Low	High	Pressure relief valves, certified components
Ignition risk due to electrical components	Low	High	Intrinsically safe design principles, grounding, ventilation
Inaccurate measurement data due to sensor errors	Medium	Medium	Sensor calibration, redundant measurements
Insufficient documentation during development	Low	Medium	Structured documentation process, weekly updates

Table 5: Internal Risks

Risk	Likelihood	Impact	Mitigation Strategy
Delays in hardware acquisition/ manufacturing	Medium	Medium	Early ordering, multiple suppliers
Supplier delivers components not meeting specifications	Low	High	Verification upon delivery, clear specification documents
Changes in availability of hydrogen supply for testing	Low	High	Early coordination with supplier, backup supply option
Changes in company priorities affecting supervision	Low	Medium	Regular alignment meetings, clear planning milestones
Regulatory or safety restrictions limiting hydrogen testing	Low	High	Early safety approval, compliance check with regulations

Table 6: External Risks

A Research Matrix

RQ-1	**Requirements**
Description	What functional, performance, and safety requirements must the power generation and feed system meet to be integrated into a UAV?
Research Method	Literature review and stakeholder analysis
Instruments Tools	Scientific literature, hydrogen and UAV standards, requirement templates
Output Data	System requirements specification

RQ-2	**Characteristics**
Description	What are the relevant performance characteristics of Solid Flow's cool gas generator and Stellar Space Industries' flow control system?
Research Method	Technical analysis and literature study
Instruments Tools	Supplier datasheets, technical documentation, prior test data
Output Data	Performance characteristics overview

RQ-3	**Flight-Time Improvement**
Description	What flight-time improvement is theoretically achievable with hydrogen storage and fuel cells compared to state-of the-art UAV battery systems?
Research Method	Analytical modelling and comparison
Instruments Tools	Energy density calculations, MATLAB/Excel models
Output Data	Theoretical flight-time estimation

RQ-4	**System Architecture**
Description	Which system architecture best balances safety, efficiency, weight, system complexity, and manufacturability for the power generation and feed system?
Research Method	Conceptual design and trade-off analysis
Instruments Tools	Morphological chart, decision matrix
Output Data	Selected system architecture

RQ-5	**Component Selection**
Description	Which components (fuel cell, intermediate electrical storage, power electronics) are most suitable based on the system requirements and design constraints?
Research Method	Component selection study
Instruments Tools	Supplier datasheets, selection criteria tables
Output Data	Selected component list with justification

RQ-7	**Electrical Architecture**
Description	What electrical architecture ensures stable power delivery from the fuel cell system to state-of-the-art UAV propulsion systems and onboard electronics?
Research Method	Electrical system design
Instruments Tools	Electrical schematics, simulation tools
Output Data	Electrical architecture and schematics

RQ-8	**System Performance**
Description	How does the integrated hydrogen-based power system perform during ground testing in terms of power output, stability, efficiency, and safety?
Research Method	Experimental testing
Instruments Tools	Hydrogen supply, sensors, data acquisition system
Output Data	Measured performance and test results

RQ-9	**Feasibility and Risk**
Description	What technical risks, failure modes, or limitations affect the overall feasibility of implementing the system in operational UAV flights?
Research Method	Risk analysis and evaluation
Instruments Tools	FMEA, test observations, design review
Output Data	Feasibility assessment and risk overview

B Work Packages

WP#	WP-1	**Start:**	02/02/2026
Title	Planning	**End:**	22/02/2026
Objectives	Define the project scope, requirements, and test strategy for the hydrogen-based power system test bench.		
Inputs	Project assignment, background literature, mission scenario description		
Activities	1. Literature study on hydrogen storage and fuel cells [20] 2. Analysis of mission scenario and constraints [10] 3. Definition of functional and safety requirements [20] 4. Definition of test strategy and success criteria [10] 5. Writing and finalising the project plan [60]		
Deliverables	1. Literature review summary 2. System requirements specification 3. Test strategy and safety considerations 4. Approved project plan		
Hours	120		

WP#	WP-2	**Start:**	23/02/2026
Title	Design	**End:**	29/03/2026
Objectives	Develop a detailed and buildable design for the hydrogen-based power system test bench.		
Inputs	System requirements specification, project plan		
Activities	1. Conceptual design of UAV architecture [40] 2. Development of multiple conceptual test bench architectures [40] 3. Definition of system boundaries and interfaces [20] 4. Trade-off analysis and concept selection [10] 5. Detailed mechanical and electrical design [80] 6. Component selection and verification against requirements [10]		
Deliverables	1. Selected test bench concept 2. CAD models and mechanical drawings 3. Electrical schematics 4. Bill of materials (BOM)		
Hours	200		

WP#	WP-3	**Start:**	30/03/2026
Title	Build	**End:**	03/05/2026
Objectives	Procure, assemble, and integrate the hydrogen-based power system test bench.		
Inputs	Detailed design documentation, bill of materials		
Activities	1. Supplier selection and procurement of components [??] 2. Manufacturing of mechanical parts where required [40] 3. Assembly of mechanical, electrical, and fluidic subsystems [80] 4. Integration of fuel cell, storage, and power electronics [80]		
Deliverables	1. Fully assembled and integrated test bench 2. Updated BOM and cost overview 3. Assembly and integration documentation		
Hours	200		

WP#	WP-4	**Start:**	04/05/2026
Title	Test	**End:**	24/05/2026
Objectives	Verify the performance and feasibility of the hydrogen-based power system through experimental testing.		
Inputs	Integrated test bench, test plan		
Activities	1. Finalisation of test procedures and safety measures [20] 2. Execution of ground tests under controlled conditions [60] 3. Data logging and documentation of test results [20] 4. Analysis of measured data and comparison with requirements [20]		
Deliverables	1. Test logs and raw measurement data 2. Performance analysis results 3. Technical feasibility assessment		
Hours	120		

WP#	WP-5	**Start:**	25/05/2026
Title	Report	**End:**	14/06/2026
Objectives	Document the project work, results, and conclusions in a clear and professional manner.		
Inputs	Project documentation, test results, analysis outputs		
Activities	1. Writing progress report [10] 2. Finalising documentation of design, build, and test phases [10] 3. Submitting draft graduation report [40] 4. Incorporating feedback into final graduation report [20] 5. Writing reflection report [20] 6. Preparing company presentation [10] 7. Preparing poster presentation [10]		
Deliverables	1. Final project report 2. Reflection report 3. Company presentation assessment by Company Supervisor 4. Poster presentation preparations		
Hours	120		

References

DJI - Official Website — dji.com. (n.d.). `https://www.dji.com`. ([Accessed 11-02-2026])

Elling, S., & Andeweg, B. (2012). *Report writing for readers with little time*. Wolters-Noordhoff bv.

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