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# REDHY

## Redox-Mediated economic, critical raw material free, low capex and highly efficient green hydrogen production technology

# REDHY - Deliverable report

DELIVERABLE 1.4 – Midterm publishable summary report

The project is supported by the Clean Hydrogen Partnership and its members.

Clean Hydrogen Partnership

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| **Author(s)** | Angelika Bullinger | |
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| | | | |

# Public Summary

The REDHy project involves developing a hybrid electrolysis system that combines the principles of an electrolyser and a redox-flow battery. The aim is to create a system comprising a 5-cell short stack. The cells of the stack contain 3D-printed electrodes and bipolar membrane. What makes the system special is the decoupled gas evolution from the cell. This is achieved by using redox-mediators that can transport electrons. The gas will be produced in an external reactor containing heterogeneous catalysts. The redox-mediator is charged or discharged at the electrode and the heterogeneous catalyst, which enables gas evolution at the catalyst outside the cell.

The focus is on developing the 3D-printed electrode, the bipolar membrane, the redox-mediators and the heterogeneous catalyst. All components are free of CRM. The aim of the 3D-printed electrode is to enable advanced electrolyte distribution and electron transfer. The bipolar membrane consists of a PEM and an AEM, which split water into hydroxide and protons at their interface using water dissociation catalyst. The anion/proton exchange membranes are fluorine free. The redox-mediator should be tailored to the system's approach. The target for the redox mediator is stability according to the number of cycles for long-term operation of the REDHy system, high solubility, and scalability. The heterogeneous catalysts are free of CRM, enabling the production of hydrogen and oxygen

By the end of the project, an efficient system with decoupled gas evolution will be developed at TRL4.

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# Abbreviations & Definitions

| ***Abbreviation*** | **Explanation** |
|---|---|
| ***CRM*** | Critical raw materials |
| ***WP*** | Work packages |
| ***CROC*** | Cathodic redox couple |
| ***AROC*** | Anodic redox couple |
| ***LCA*** | Life cycle assessment |

# 1 Introduction

This midterm publishable summary report will describe the project's progress so far. The report period is from 01/01/2024 to 31/12/2025 (M1-M24). The REDHy project tackles the limitations of contemporary electrolyser technologies by fundamentally reimagining water electrolysis, allowing it to surpass the drawbacks of state-of-the-art (SoA) electrolysers and become a pivotal technology in the hydrogen economy. REDHy is entirely free of critical raw materials and doesn't require fluorinated membranes or ionomers, while maintaining the potential to fulfil a substantial portion of the 2024 KPIs. In accordance with Europe's circular-economy action plan, a 5-cell stack with an active surface area exceeding 100 $cm^2$ and a nominal power of 1.5 kW will be developed, capable of managing a vast dynamic range of operational capacities with economically viable and stable stack components. The REDHy technology presents an enthralling alternative pathway for green hydrogen production, employing a series of cutting-edge innovations to create a more economically viable process. Utilizing redox mediators and nano-engineered heterogeneous catalysts in conjunction with 3-D electrodes, the technology separates anode and cathode reactions, ultimately enhancing electrolysis safety and cell performance.

There are 8 work packages (WP). WP2-5 perform component development. WP2 develops the redox-mediator, WP3 the bipolar membrane, WP4 the electrodes and WP5 develops the heterogeneous catalyst and performs single cell testing and validation. WP6 is responsible for the stack design and system. In WP7 a LCA is performed and WP8 is responsible for communication, dissemination and exploitation.

Key objectives:

- **Material development**: Develop highly efficient and durable materials free of critical raw and fluorine free materials for the REDHy technology, especially the membranes, ionomers, electrodes, redox mediators, and heterogenous oxygen and hydrogen evolution catalysts. Demonstrate optimization strategies for the porous electrodes to enhance their mass transport characteristics and enhance energy efficiency.
- **Technology validation**: Demonstrate a drastic reduction in interface resistances across all cell components. Demonstrate the decoupling of oxygen and hydrogen production and enabling the REDHy system to operate at minimum 5% of partial load operation.
- **Stack development**: development of a large area short stack (5 cells) with an active surface area of > 100 $cm^2$ per cell and a nominal power of >1.5 kW. Validate the stack's efficiency and robustness to address dynamic situations frequently occurring when the electrical grid is fed by a large proportion of renewable energy sources.
- **Stack integration**: Integrate the short stack in a prototype full system. Demonstrate the operation of the REDHy electrolyzer over 1200 h.

# 2 Context and overall objectives

The target of the REDHy project is to develop a decoupled gas evolution electrolysis system which is entirely free of critical raw materials and doesn’t require fluorinated membranes or ionomers. It will be developed a 5-cell stack with an active area of 100 $cm^2$ per cell and a nominal power of 1.5 W, capable of managing a vast dynamic range of operational capacities with economically viable and stable stack components. These endeavours will guarantee lasting and efficient performance at elevated current densities (1.5 A*cm-2 at Ecell 1.8 V/cell) at low temperatures (60 °C) and suitable hydrogen output pressures (15 bar). The ultimate objective is to crate a prototype, validate it in a laboratory setting 1200 hours at a maximum degradation of 0.1 %/1000 hours and achieve TRL4.

**Project objectives:**

- **Objective 1:** Develop highly efficient and durable materials free of critical raw and fluorine free materials for the REDHy technology, especially the membranes, ionomers, electrodes, redox mediators, and heterogenous oxygen anf hydrogen evolution catalysts to allow the development of a large area short stack (5 cells) with an active surface area of > 100 $cm^2$ per cell and a nominal power of >1.5 kW with adequate manufacturing quality guided by Europe's circular-economy action plan for a cleaner and more competitive Europe.
- **Objective 2:** Validate the stack's efficiency and robustness to address dynamic situations frequently occurring when the electrical grid is fed by a large proportion of renewable energy sources or if the system is directly interfaced with RES.
- **Objective 3**: Eliminate the use of and the need for critical raw materials and fluorinated membranes and ionomers at stack level
- **Objective 4**: Demonstrate optimization strategies for the porous electrodes to enhance their mass transport characteristics and enhance energy efficiency.
- **Objective 5:** Demonstrate a reduced energy consumption of at least 48 $kWh*kg^{-1}$ $H_2$ by implementing highly reversible, stable redox mediators with enhanced kinetics
- **Objective 6**: Demonstrate a drastic reduction in interface resistances across all cell components leading to energy efficiencies >82%
- **Objective 7**: Demonstrate the decoupling of oxygen and hydrogen production and enabling the REDHy system to operate at minimum 5% of partial load operation (nominal load 1.5 $A/cm^2$) without exceeding 0.4 % of $H_2$ concentration in $O_2$
- **Objective 8:** Demonstrate that the REDHy technology is capable to perform efficient and direct seawater electrolysis
- **Objective 9**: Integrate the short stack in a prototype full system
- **Objective 10**: Demonstrate the operation of the REDHy electrolyzer at 1.5$A*cm^{-2}$ with electricity consumption of 48 $kWh*kg^{-1}$ over at least 1200 hours of operation with a degradation of 0.1 % /1000 hours

A comparison of REDHy's KPIs targets by 2028 (end of project) to the SRIA (PEMWE and AWE) and call topic in Table 1 reveals that REDHy’s disruptive approach has the potential to accelerate water electrolysis targets initially set for 2030. Table 2 highlights the topic requirements and the pertinence of the REDHy objectives to the work program.

# 3 Work performed and main achievements

**WP1 – Project management and coordination**

| | |
|---|---|
| **Lead** | DLR |
| **Duration** | M1-M48 |

WP1 focuses on the successfully implementation of the project and the project progress and compliance of objectives in a timely manner, verifying quality and costs. It coordinates the consortium following the rules of the GA and internal CA. Also, it communicates administrative information among partners and between consortium and the EC.

**Main achievements:**

Monitoring and coordination of project activities: To monitor the progress of the project there is a monthly meeting. Here every WP is presenting the progress of the last month. This helps to proceed the project as planned and detect problems and solve them.

Organization of project meetings:

Project meetings held:

- Kick-off meeting (KOM): February 2024, Brussels (hosted by DLR)
- 1st General Assembly Meeting (GA1): October 2024, Valencia (hosted by UPV)
- 2nd General Assembly Meeting (GA2): February 2025, Brussels (hosted by DLR)
- Review Meeting: September 2025, online
- 3rd General Assembly Meeting (GA3): December 2025, Messina (hosted by CNR)

Reporting to EC:

A periodic report was submitted in August 2025 and approved.

Quality assurance and knowledge and data research management:

A data management plan was developed and the results of 2024 was reported to the knowledge hub.

Annual reporting for the Clean Hydrogen JU

The annual reporting of 2024 was submitted to the Clean Hydrogen JU.

KPIs reporting and monitoring:

The project KPIs are reported and monitored in every monthly meeting.

## WP2 – Redox-mediators

| | |
|---|---|
| **Lead** | UPV |
| **Duration** | M1-M48 |

WP2 focuses on the synthesis and modification of the two redox mediators CROC and AROC. These mediators are designed to facilitate water electrolysis, with cathodic redox couples (CROC) targeting a different potential range for hydrogen evolution, and anodic redox couples (AROC) aiming for oxygen evolution. Redox mediators are molecules that facilitate electron transfer between species that do not react efficiently on their own overcome kinetic bottlenecks and expand accessible reactions. Enable indirect electrochemical pathways by shuttling electrons, they lower kinetic barriers and improve reaction rates. To find suitable molecules the following route was followed: Use theoretical calculations to guide the selection and modification of redox mediators. Develop and optimize synthetic routes for CRM-free cathodic redox couples (CROC) and anodic redox couples (AROC). Evaluate purity of the synthetized redox mediators through analytical, physical and spectroscopic techniques. Evaluate electrochemical properties (reversibility, stability, redox potentials) and select the best-performing mediators. Later larger quantities of the most promising mediators using green chemistry principles, ensuring stability for integration in the system should be produced.

**Main achievements:**

In WP2, the synthesis, intentional modification, and assessment of the redox performance of two types of redox mediators were conducted. Calculations to determine the redox potentials of proposed molecules and complexes were developed and successfully compared to literature values. Here, we use the Density Functional Theory (DFT) theory to calculate the redox potential of several potential organic molecules in the electrolyzer water cathodic redox couple, and evaluate their application potential. Synthesized molecules were delivered in different amounts to the project partners.

## WP3 – Bipolar membrane

| | |
|---|---|
| **Lead** | CENmat |
| **Duration** | M1-M36 |

WP3 focuses on the development of fluorine-free bipolar membranes. This involves the enhancement of CENmat's fluorine-free PEM (ProFLX) and the development of a fluorine-free cation-exchange ionomer. The aim is the combination of the enhanced ProFLX and the AEM of CENmat AnionFLX.

**Main achievements:**

- PFAS free polymers:
  - Both PFAS-free AEM and PEM validated in performance and durability
- AEM: AionFLX™ by CENmat
  - PFAS-free membrane produced via simple and scalable synthesis method
  - IEC of 1.1 meq/g with conductivity >80 mS/cm in 1M KOH @ 50°C
  - Swelling around 20%
- Development of PFAS-free PEM
  - PFAS-free material developed

- IEC of 1.58 meq/g
- Water uptake below 15%
- Tensile strength 250MPa
- Ease of production and scalable for casting


*Figure 1: CENmat PFAS-free PEM*

- Production method Bipolar Membrane (BPM)
  - Improved production of PEM/WDC/AEM layering
  - Type of WDC used
  - A new type of WDC, CRM-free was developed and deposited on the PEM

## WP4 – Electrode design and optimization

| | |
|---|---|
| **Lead** | CNRS |
| **Duration** | M1-M36 |

WP4 focuses on the development of a 3D-printed electrode. They quantify the electron transfer kinetic of the redox-mediators on electrodes and between redox-mediators and heterogeneous catalysts.

**Main achievements:**

- 3D porous electrodes with different structures were printed by using suitable graphene oxide inks.
- The composite materials after pyrolysis show good mechanical stability, high electrical conductivity, and high electrochemical activity and stability.
- The carbon-based 3D porous electrode shows decent performance in redox flow cell compared with commercial graphite felt.
- Method for measuring AROC/CROC and catalyst activity developed

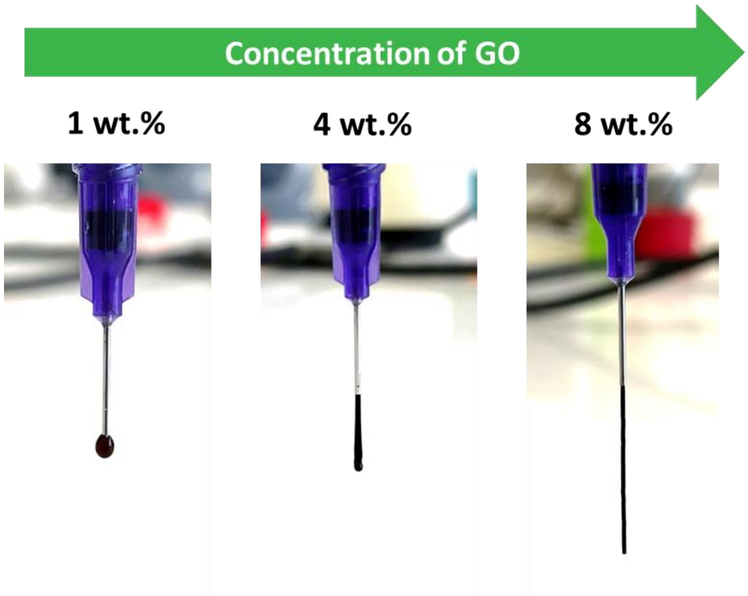


*Figure 2: Ink droplets with different GO concentration*

## WP5 – Single cell REDHy prototype development and validation

| | |
|---|---|
| **Lead** | CNR |
| **Duration** | M1-M40 |

WP5 focuses on the development of CRM free heterogeneous catalysts and the testing and validation of single cells. The single cell should achieve a performance of < 1.8 V/cell at 1.5 A/cm$^2$ (> 82 % voltage efficiency) and a degradation rate < 5 µV/h/cell at nominal/cycled operational conditions.

**Main achievements:**

- Heterogeneous catalysts
  - Developing non-CRM heterogeneous catalysts/electrocatalysts that operate outside the cell in specific catalytic-bed reactors as catalytic enhancers to regenerate the base redox species while producing oxygen and hydrogen gases from water.
  - Oxygen evolution electro-catalyst - NiFe layered double-hydroxides (LDH) (85:15) were developed and synthesized

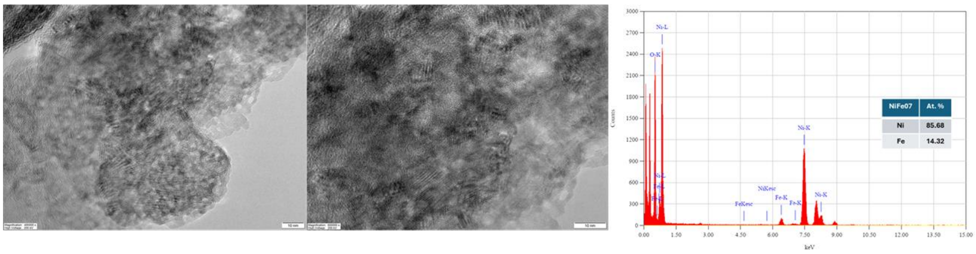


*Figure 3: Transmission electron micrographs at different magnification of NiFe layered double-hydroxides (LDH)*

  - Hydrogen evolution electro-catalyst - carbon supported and unsupported NiMo

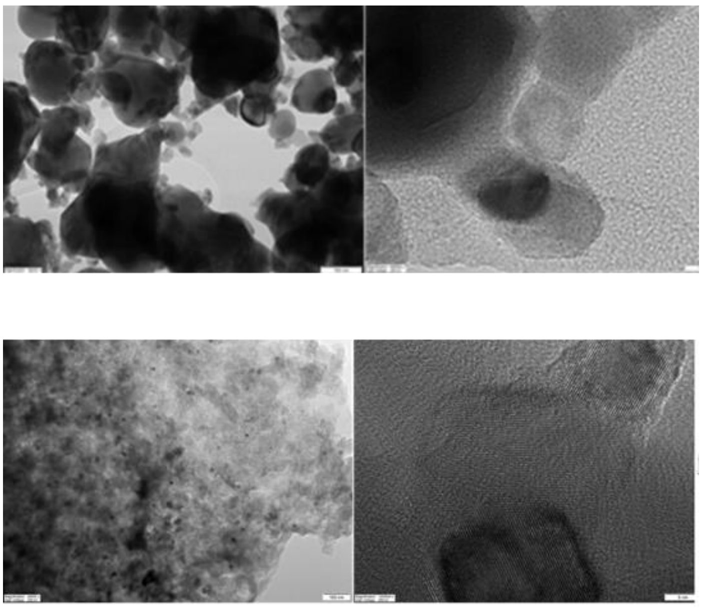

*Figure 4: Transmission electron micrographs at different magnification of NiMo unsupported (top) vs. NiMo supported*

- Electrochemical evaluation:
    - Alkaline environment heterogeneous catalysts, for oxygen and hydrogen evolution reaction, were tested in AEM single cell configuration to evaluate their activity and performance.
    - NiMo unsupported shows higher performance vs. NiMo supported
    - NiFe LDH shows higher performance vs. NiMn LDH
    - Acidic environment heterogeneous catalysts for the only hydrogen evolution reaction, were tested in PEM single cell configuration to evaluate their activity and performance.
    - $MoS_2/C$ from hydrothermal synthesis shows highest performance, with the respect to the unsupported $MoS_2$, $MoS_2/C$ (80:20 wt.%) mechanically mixed and commercial $MoS_2$.
    - First evaluation of REDHy single cell including REDOX mediators and external bed reactors but using AEM membrane was done

## WP6 – REDHy system

| | |
|---|---|
| **Lead** | DLR |
| **Duration** | M1-M48 |

WP6 focuses on the development of the system, which includes the 5-cell stack design. In this WP the developed components are getting combined and up-scaled. Also, the operation and proof of long-term operation is performed here.

**Main achievements:**

Design of the system has begun. The system includes the design of the reactor, the BoP and the selection of the system components like gas/liquid separator, gas analyser or heat exchanger. A 5-cell stack design has already been completed that take into account the requirements of an electrolyser and a redox-flow battery. There is also a design for the stack housing. Materials for the stack components have been selected.

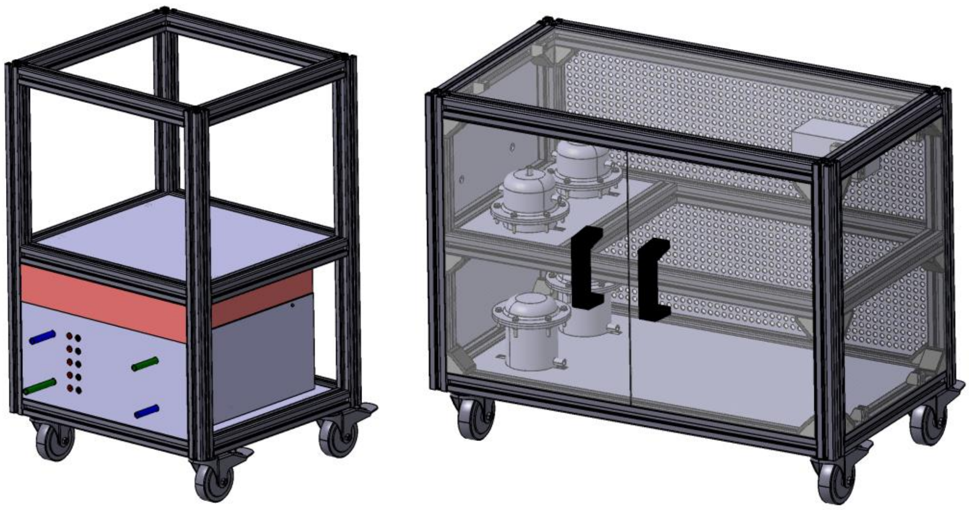

*Figure 5: System sketch with stack part (left) and gas evolution part (right)*

## WP7 – Life cycle and Technoeconomical assessment

| | |
|---|---|
| **Lead** | IDN |
| **Duration** | M13-M48 |

WP7 focuses on the performance of a LCA and TEA. This involves a preliminary LCA analysis and a TEA of the REDHy system. The aim is a final integrated LCA, Techno-economic and circularity assessment of a scaled-up REDHy system.

**Main achievements:**

Preliminary Life Cycle Assessment (LCA) of the REDHY system was started. The assessment adopts cradle-to-grave system boundaries to offer a comprehensive view of the potential environmental impacts throughout the entire lifecycle of the system. Primary data were collected by project partners, and multiple scenarios were analysed where alternative options remain under consideration. Additionally, cradle-to-gate results are benchmarked against literature references.

Following activities were performed:

- LCA of $H_2$ electrolyzers benchmarking activity
- Life Cycle Inventory definition with partners
- LCA first iteration modelling (raw material supply and manufacturing)

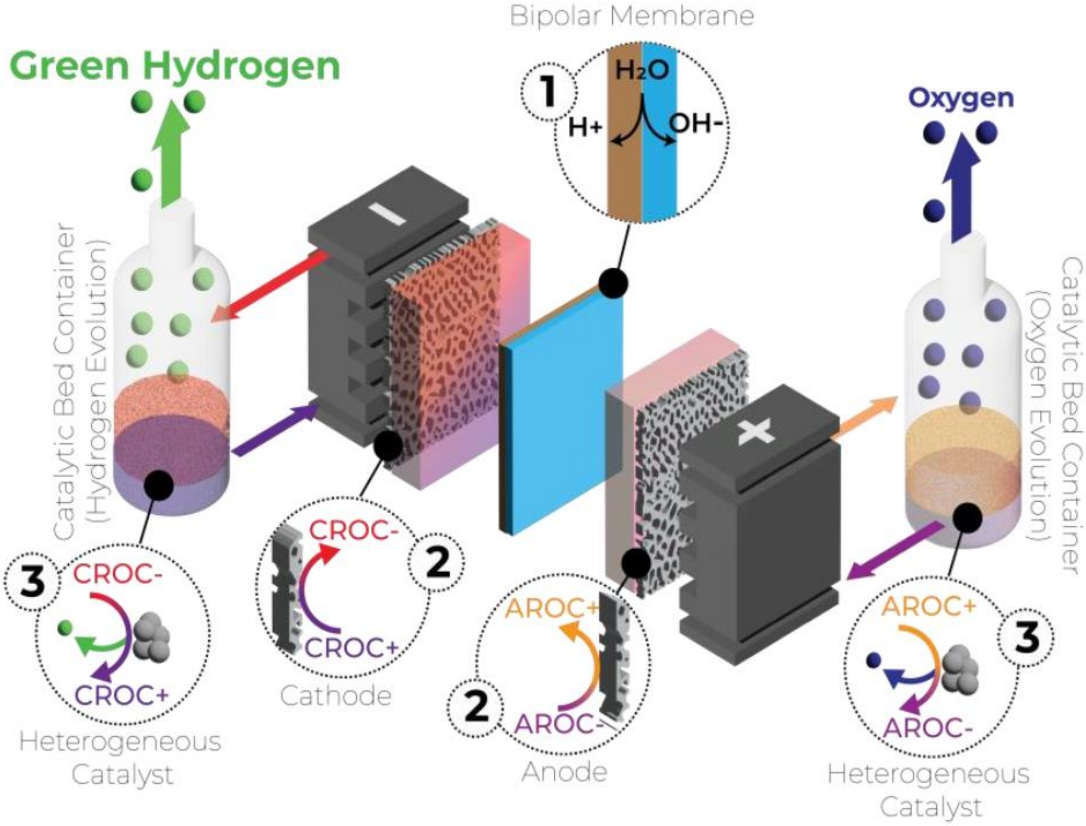


*Figure 6: REDHy concept and parts to be included in the LCA*

## WP8 – Communication, dissemination and exploitation:

| | |
|---|---|
| **Lead** | UNR |
| **Duration** | M1-M48 |

WP8 focuses on maximizing the visibility and impact of the project. This will be reached by engaging and promoting synergies with relevant stakeholders and audiences, by communicating and disseminating key results and innovations. WP8 manage and coordinate the interactions with the AB. Also, they ensure the best exploitation of the project results, identifying specific target groups

**Main achievements:**

**Project identity**

- Project logo and colour scheme defined for project templates:
  - Deliverable report
  - Milestone achievement report
  - PowerPoint Presentations
  - Meeting Agenda and Minutes

**Project Website:** www.redhy.eu

- Launched April 2024, hosted by UNR
- Project overview, partners, news, events, contact, media kit
- Shows objectives, progress, key results, and achievements
- Includes updates, deliverables, milestones, interviews, upcoming events
  → **27 news items** and **14 result-related posts**
  → **5 "Coffee Break" interviews**
  → **4 newsletters** published

**Social Media: LinkedIn Performance**

- Promoting website content & upcoming events
  → **25 posts** published so far
  **Follower growth:** 19 → 84
- **Reach:** 5,852+ impressions
- **Consortium-led** outreach & promotion
- Active **cross-project** engagement

The first reporting period has been mostly focused on research activities, several of which are still ongoing. One scientific publication has been prepared and published:

- **Durability of nanostructured $MoS_2$ electrocatalysts for $H_2$ evolution, *Electrochemical Journal, 2025* (CNR ITAE)**

REDHy collaborates with related and co-funded projects through clustering activities:

- Sister projects highlighted on REDHy website: https://redhy.eu/collaborations
- Cross-links established with X-SEED, SEAL-HYDROGEN, EXSOTHYC & AEMELIA
  - Tobias Morawietz from DLR presented at X-SEED hybrid workshop (Jan 2025).
- REDHy webinar held (25th, Nov 2025) with related projects.
  → **"Electrolysis and Redox Flow Batteries: Combining the Two Worlds"**
- REDHy will organise a joint webinar with the cluster projects in March 2026.

*Table 3-1 Dissemination activities*

| Conferences, events and workshops | Date | Location | Partner | Activity |
|---|---|---|---|---|
| **Hannover Messe 2024 – Hydrogen & Fuel Cells** | 22-26 April 2024 | Hannover, Germany | DLR | Booth, Brochure |
| **DINAMHySE Club Meeting** | 24 April 2024 | Metz, France | CNRS | Prestation |
| **8th ERTL Symposium** | 26-29 June 2024 | Esslingen, Germany | DLR | Poster, Presentation |
| **Hy-fcell International Expo and Conference** | 8-9 October 2024 | Messe Stuttgart, Germany | DLR | Booth |
| **AEM 2024 (22nd Edition)** | 9-11 October 2024 | London, UK | CNR | Presentation |
| **GDR Redox Annual Meeting** | 16 October 2024 | France | CNRS | Presentation |
| **Hybrid workshop Water Electrolysis** | 29 January 2025 | Milaan, Italy | DLR | Workshop |
| **IHTEC 2025** | 25-28 May 2025 | Izmir, Türkiye | CNR | Presentation |
| **Hannover Messe 2025 – Hydrogen & Fuel Cells** | 31 March – 4 April 2025 | Hannover, Germany | DLR | Booth |
| **AORFB 2025** | 24-25 April 2025 | Paris, France | CNRS | Workshop |
| **European Fuel Cell Forum (EFCF) 2025** | 1-4 July 2025 | Lucerne, Switzerland | DLR | Booth |
| **76th Annual Meeting of the International Society of Electrochemistry** | 07 Sep 2025 | Mainz, Germany | CNRS | |
| **Meeting of the European Materials Research Society (E-MRS) Fall Edition** | 15 Sep 2025 | Warsaw, Poland | CNRS | |
| **Conference Chemical Society, Inorganic Section** | 11 Sep 2025 | | DNI | Presentation |

# 4 Results beyond the State of the Art

## 4.1 Background

The REDHy project significantly advances CRM-free BPM membrane electrolysis technology, enabling large-scale green hydrogen production. Besides the whole concept also the single material developments go beyond the State of the Art.

## 4.2 Procedures

Electrode 3D-printing: 3D porous electrodes with different structures were printed by using suitable graphene oxide inks. The composite materials after pyrolysis show good mechanical stability, high electrical conductivity, and high electrochemical activity and stability. The carbon-based 3D porous electrode shows decent performance in redox flow cell compared with commercial graphite felt.

Production of fluorine free PEM: PFAS free polymers:Both PFAS-free AEM and PEM validated in performance and durability. AEM: AionFLX™ (CENmat) PFAS-free membrane produced via simple and scalable synthesis method with IEC of 1.1 meq/g and conductivity >80 mS/cm in 1M KOH @ 50°C with a swelling around 20%. Development of PFAS-free PEM:PFAS-free material developed with IEC of 1.58 meq/g, Water uptake below 15% and Tensile strength 250MPa.

# 5 Policy-Relevant Evidence of Your Project Results

The REDHy technology provides an alternative pathway besides standard electrolysis technology towards the 2050 climate neutrality objective (1.5 °C limit is only possible if global net-zero is reached by 2050). The system can act as an electrolyzer and as a battery providing the possibility to produce hydrogen at a later stage. REDHy plays an important role to the hydrogenization of transport and energy sector. REDHy uses only non-CRM and fluorine free materials which reduce the costs of the "electrolyzer" significantly. Aligned with the European Green Deal, the EU Hydrogen Strategy, and the Clean Hydrogen Partnership, REDHy supports the broader objective of climate neutrality.

**The European Green Deal is directly addressed through REDHy technology**:

**Clean Energy:** The REDHy system can be coupled to RES and will thus produce green hydrogen which can be used as clean energy on different sectors.

**Circular Economy:** As REDHy uses only non-CRM and fluorine free materials recycling of the materials is less complicated. The materials are designed to be recoverable materials or only embedded in cost-effective non-CRM materials.

**Industrial Decarbonization**: The RDHy system produces affordable hydrogen which can be used by EU key industries like steel production, Oil & Gas (Refining & Upgrading), Chemicals (Ammonia & Nitrates), Cement (Calcination & Energy), Petrochemicals (Ethylene, Propylene).

**Transport:** In future heavy transport (Trucks, Buses, Trains, Ships) may use hydrogen as energy carrier and REDHy could be directly implemented onto the transport or at refuelling stations.

# 6 Conclusion and Recommendation

At end of RP1, the REDHy project has shown the potential of the different technologies contributing to the whole concept. In the following project execution the combination will be in focus.

The overarching objective of the project is to deliver a fully CRM-free electrochemical system that is not only chemically stable and cost-effective but also environmentally sustainable. The research programme is structured around a tightly coupled synthesis-characterization-optimization cycle that begins with the preparation of advanced redox-mediated organic compounds (AROC and CROC) and culminates in a fully integrated single-cell and stack-level demonstration, accompanied by life-cycle and techno-economic assessment. The AROC and CROC compounds are characterized by elemental analysis, NMR, UV-vis, and mass spectrometry to confirm purity and to identify any side products. These redox mediators are specifically tailored to operate under the targeted conditions, with measured redox potentials that align with the overall cell voltage. Ex-situ electrochemical tests—cyclic voltammetry and square-wave voltammetry—are conducted to validate the redox couples and to benchmark their kinetics.

The electrode architecture will be conceived using computational fluid dynamics to optimize mass transport and electron pathways. The final designs are fabricated via 3-D printing (direct ink writing) with a ink comprising conductive carbon or graphite powders dispersed in a polymeric matrix. The printing parameters—layer thickness, infill density, and post-print annealing—are iteratively tuned to produce highly porous surfaces that maintain structural integrity at the cell operating potentials.

A high-performing bipolar membrane is engineered by combining CENmat's proton exchange polymer, ProFLX, with microphase-separated copolymers that provide robust mechanical support and tailored ion-exchange domains. This composite membrane is non-per-fluorinated, thereby mitigating the environmental and disposal issues associated with PFSA-based membranes. Comprehensive testing—proton conductivity (four-probe), ion exchange capacity (titration), mechanical toughness (tensile testing), and water uptake (gravimetric analysis)—is carried out.

Building on the single-cell data, a short-stack prototype is fabricated by stacking multiple identical cells. The stack uses graphite and stainless-steel base materials, with components that ensure manufacturability at scale. The REDHy system, a modular stack that incorporates both homogeneous and heterogeneous reactors, is assembled to enable a better understanding of electrochemical reaction rates.

The REDHy system—comprising the stacked cells and the heterogeneous reactors—offers a comprehensive platform to study the interplay between pressure, mass transport, and reaction kinetics under real-time operating conditions.

A assessment of the environmental and economic impacts is conducted via life-cycle assessment (LCA), techno-economic assessment (TEA), life-cycle inventory (LCI), and circularity evaluation. These analyses are performed on the short-stack prototype and inform iterative improvements in materials and components. The goal is to achieve a platform that delivers high functional performance, long-term stability, and demonstrable safety, while also ensuring that the overall life-cycle footprint—energy consumption, resource depletion, and waste generation—is minimized and aligned with circular economy principles. The results of these studies will provide the data necessary for a future commercial deployment of the REDHy system, delivering a sustainable, high-performance, and cost-effective catalyst-free hydrogen production pathway.

# 7 Deviations from Annex 1

During the first 24months of the REDHY project, there have been no major deviations to be reported.

# 8 Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

**Project partners:**

| # | Partner short name | Partner Full Name |
|---|---|---|
| ***1*** | DLR | DEUTSCHES ZENTRUM FUR LUFT – UND RAUMFARHT EV |
| ***2*** | CNRS | CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIC |
| ***3*** | UNR | UNIRESEARCH BV |
| ***4*** | UPV | UNIVERSITAT POLITECNICA DE VALANCIA |
| ***5*** | IDN | INDUSTRIE DE NORA SPA-IDN |
| ***6*** | CENMAT | CUTTING-EDGE NANOMATERIALS CENMAT UG HAFTUNGSBESCHRANKT |
| ***7*** | CNR | CONSIGLIO NAZIONALE DELLE RICERCHE |

***Disclaimer/ Acknowledgement***



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