# Community of Practice Electrolysis

Accelerating electrolysis innovation

COPE | Community of Practice Electrolysis

**COPE connects experts and testing facilities to accelerate electrolysis innovation and scale-up, while building an international knowledge community through harmonised standards and collaboration**

# Executive summary

Electrolyser technologies are developing rapidly, but their scale-up remains constrained by inefficiencies in how testing is organised and applied. Across the value chain, uncertainty about testing methods, conditions and performance metrics leads to inconsistent results, limited comparability and slow feedback loops between developers, manufacturers and end users.

A central issue is the lack of alignment in testing approaches. Protocols differ between organisations and facilities, data is not easily shared or interpreted and testing is often repeated under slightly different conditions. At the same time, a wide range of testing infrastructure is already available, from laboratory-scale component testing to large-scale system demonstrations. However, this landscape remains difficult to navigate and is not yet functioning as a coherent system.

The Community of Practice Electrolysis (COPE), an initiative by GroenvermogenNL and TNO, addresses this challenge by organising collaboration around testing, validation and learning. It brings together industry, research organisations and testing facilities in an international context, with a focus on practical alignment and knowledge exchange. Rather than adding new infrastructure, COPE focuses on better connecting and utilising what already exists.

COPE operates through three complementary pillars. Harmonised testing, benchmarking and certification aim to improve the consistency and comparability of results. The Distributed Test Center connects facilities into a coordinated network, enabling more efficient routing of testing activities across locations and scales. The Electrolyser Intelligence Platform supports data-driven insights, using privacy-preserving methods that allow participants to benefit from shared analysis without disclosing sensitive information.

This paper introduces these pillars of COPE and the concrete steps taken within COPE, including the development of harmonised protocols, pilot test cases, a capability map and initial governance principles. Together, these elements form the basis for a more coordinated approach to testing and validation. In addition, the paper provides a first overview of the current electrolysis testing landscape, covering a broad range of facilities across different countries, technologies and scales.

By improving alignment, transparency and collaboration, COPE supports more efficient learning cycles and more effective use of testing infrastructure. This contributes to reducing uncertainty in technology development and enables more structured progress towards large-scale deployment of electrolysis systems.

# Content

‘COPE connects private and public sector specialists with research and testing facilities across Europe – creating a unique ecosystem to meaningfully accelerate electrolysis innovation and with it, the energy transition’

# Towards a leading hydrogen ecosystem: from innovation to scaling-up

Transitioning to a climate-neutral energy system requires decisive action, innovation and strong cross-sector collaboration. Green hydrogen is widely recognised as a key pillar in this transition – a flexible, scalable solution for decarbonising industry, balancing renewable energy and enabling entirely new value chains.

The Netherlands has the historic opportunity to be more than merely a participant in this transition. With its strong industrial base, world-class knowledge institutions and energy infrastructure, it can be a pathfinder country – a place where green hydrogen technologies are not only invented, but also tested, proven, scaled and brought to market.

Achieving this ambition demands more than just developing electrolysis technologies. The ability to test, validate and scale the latter effectively and efficiently is equally critical. At the moment, the testing landscape is still fragmented, with limited standardisation and access to facilities. This slows progress and raises costs, precisely when speed and coordination matter most.

This is why GroenvermogenNL and TNO have initiated the Community of Practice Electrolysis (COPE). COPE connects private and public sector specialists with research and testing facilities across Europe – creating a unique ecosystem to meaningfully accelerate electrolysis innovation and with it, the energy transition.

COPE's harmonised testing protocols, an integrated network of testing facilities and enhanced learning from data by application of AI, will shorten the path from laboratory to market.

In doing so, the community will strengthen the conditions for faster scaling-up thereby positioning the Netherlands at the centre of the European hydrogen testing landscape.

In addition, COPE contributes to a hydrogen ecosystem that is both robust and internationally competitive by connecting national strengths and aligning with European developments.

This paper sets out which steps are being taken and the opportunities that lie ahead. COPE invites all stakeholders to contribute actively. Building a future-proof hydrogen economy is a collective endeavour – with the Netherlands ready to be both pathfinder and leading hub.

**Marjan Oudeman**
Chair GroenvermogenNL

**Richard Braal**
Director Industry TNO

# 1

# Introduction

Introducing the Community of Practice Electrolysis

# 1. Introduction

## 1.1 Introducing the Community of Practice Electrolysis: harmonising electrolyser testing to accelerate scale-up

Electrolyser technologies are advancing rapidly, but derisking scale-up is essential for success. Validation of innovations plays a crucial role across all stages of innovation from fundamental research to industrial-scale deployment. Nowadays, this testing landscape is fragmented: by creating a better understanding of what to test, at which scale, where, and at which moment in the innovation cycle, we can speed up innovation, manage risks and reduce cost in product development.

This paper outlines how COPE — the Community of Practice Electrolysers— brings together Dutch and European organisations to accelerate innovation by harmonising testing, unlocking shared knowledge and derisking the scale-up of electrolysis.

## 1.2 An initiative by TNO and GroenvermogenNL

COPE is an initiative by GroenvermogenNL (GVNL) and TNO. Both share the ambition to build a strong hydrogen ecosystem using the unique strengths of the Dutch landscape and accelerate the commercialisation of electrolysis technologies. Both organisations recognise that fragmented testing approaches and inconsistent standards hinder progress throughout the supply chain.

**Together GVNL and TNO aim to accelerate innovation by:**

- Creating a coherent national (and international) testing landscape
- Enabling shared learning between industry and research
- Derisking investments in scale-up of electrolyser technology
- Embedding the Netherlands as an innovation hub in the European hydrogen value chain

This collaboration ensures that testing and learning become a coordinated international effort which strengthens the European manufacturing industry.

*Signing of the Memorandum of Understanding by Marjan Oudeman (GroenvermogenNL) and Richard Braal (TNO), marking the start of a multi-year program to accelerate innovation and scale up electrolysis for green hydrogen production.*

‘Advancing the hydrogen industry requires collaboration and trust in technology. Through COPE, the harmonisation of testing helps increase confidence in electrolyser technologies across the market. This improves the value and credibility of test results and enables us to provide potential customers with greater assurance, ultimately accelerating real-world implementation of hydrogen solutions.’

**Rokus van Iperen,**
Program director Electrolyzer stack development (Bosch)

# 2

# The benefits of a Community of Practice Electrolysis

Building a coordinated ecosystem for electrolysis testing by means of three pilars

# 2. The benefits of a Community of Practice Electrolysis

### 2.1 Barriers to electrolysis innovation and scale-up

Despite the strong momentum behind electrolysis, innovation and scale-up is still held back by a series of systemic obstacles. Supply chains remain immature. Rather than testing unproven technology at customer sites, creating opportunities for testing stacks or systems can derisk and reduce costs. Product improvement can be accelerated and derisked by enabling rapid and effective feedback loops between component developers and OEMs.

Uncertainty about long-term performance also results in over-engineering such as excessive catalyst loading or the use of precious-metal coatings, further increasing costs. In addition, fragmented testing protocols make results difficult to compare and force organisations to develop their own approaches. Combined with a lack of shared learning, this leads to duplicated testing efforts and a limited understanding of reliability and performance trends across the value chain.

### 2.2 Building a coordinated ecosystem for electrolysis testing and learning

COPE (Community of Practice Electrolysers) is an innovation-oriented community, connecting component suppliers, OEMs, testing facilities, research institutes, academia, certifying organisations and end users. Its mission is to align innovation efforts across the supply chain and to enable knowledge generation and shared learning at scale.

COPE acts as:

- a promotor of harmonised testing methods and equipment
- a gateway to testing facilities across the Netherlands
- a facilitator for pre-competitive shared learning across the industry.

By connecting national and European initiatives it turns effeorts to accelerate implementation of electrolysers into a coherent international programme, ensuring that testing and validation is carried out consistently, strategically and in close collaboration with industry.

## 2.3 Connecting stakeholders throughout the electrolysis value chain and beyond

COPE is designed for a broad group of electrolysis value chain stakeholders, bringing together organisations involved in the development, deployment, testing and standardisation of electrolyser technologies. This includes producers of electrolyser systems and components, industrial end users in need of reliable testing, certification bodies and the providers of testing facilities and infrastructure. In addition, trade and industry associations play an important role in connecting initiatives and aligning sector-wide interests.

There are already numerous projects and platforms focused on R&D and innovation, such as ISPT, VoltaChem and CleanHyPro, as well as a wide range of testing facilities. However, there is currently no dedicated community or long-term public-private programme focused specifically on testing, benchmarking and standardisation. COPE aims to foster close interaction with these existing initiatives, while maintaining a distinct role within the ecosystem.

Beyond the Dutch context, COPE actively engages with European applied research organisations and partners. Electrolysis innovation is inherently global and, as international initiatives continue to emerge, there is a clear need for more integrated testing infrastructures and harmonised approaches. COPE addresses this by strengthening collaboration within the Dutch ecosystem while actively connecting with European partners, supporting alignment with emerging standards and ensuring that the Dutch electrolysis sector remains competitive in the rapidly developing global hydrogen market.

> ‘The Task 30 Electrolysis of the Fuel cell and Electrolyser TCP organized by the International Energy Agency focuses on advancing the electrochemical production of hydrogen through water electrolysis, a crucial technology for future energy systems by coordinating research and development (R&D) and benchmarking. A Community of Practice Electrolysis to de-risk electrolysis scale-up by aligning on harmonization and developing a coherent international testing landscape is an important cornerstone in this endeavor.’
>
> **Boris Bensmann, taskmanager AFC TCP (IEA)**

## 2.4 Three pillars of COPE

COPE facilitates the acceleration and scaling-up of innovations by means of the following three pillars.

### 1. Harmonised testing, benchmarking & certification

This pillar aims to eliminate fragmentation in current testing practices by developing harmonised protocols and, over time, certification pathways. The objective is to create reliable, transferable and comparable results across facilities and technologies. This includes mapping existing protocols, identifying gaps and developing standardised methodologies that support international collaboration and benchmarking.

- Development of harmonised test protocols
- Benchmarking of electrolysis technologies across facilities
- Comparable and reliable test results for industry and research

### 2. Distributed Test Center (DTC)

The Distributed Test Center connects existing testing facilities as a single, coordinated network. It offers a unified entry point for companies seeking testing support and enables testing at the right scale, at the right facility, for the right use case. Linking laboratory testing to mid-scale facilities, the DTC will develop the scaling rules essential for technology validation. It will also reduce duplication, improve efficiency and strengthen national testing capacity.

- One coordinated network of Dutch electrolysis test facilities
- A single entry point for companies seeking testing support
- Testing at the right scale and facility, from lab to pilot scale

### 3. Electrolyser Intelligence Platform

This pillar focuses on advanced data analytics and AI-driven modelling to uncover performance and reliability insights that cannot be captured through traditional testing alone. Recognising that industry partners treat operational data as a key competitive asset, the platform is designed to function without requiring stakeholders to share raw data.

Instead, it uses privacy-preserving technologies — such as federated learning and secure computation methods — to allow each partner to keep full control of their proprietary datasets while still benefiting from ecosystem-wide learning. This approach allows COPE to derive aggregated, anonymised performance patterns and improvement opportunities for its members, without exposing sensitive information.

The result is a collective intelligence layer that accelerates progress on electrolyser lifetime and performance, while fully respecting the confidentiality, ownership, and competitive positioning of each industrial partner.

- Secure data collaboration across the ecosystem
- Advanced analytics to improve performance and reliability
- Insights without sharing confidential company data

> ‘As an EPC installing multiple green hydrogen plants, we believe we have a contribution to make on aspects of safety, cost, and performance. We must always remain close to the latest technology developments: through initiatives like COPE, we can share practical insights and remain closely aligned with the latest technological developments, helping to strengthen the Netherlands’ leading position in hydrogen innovation.’
>
> **Greg Stock, Director Green Hydrogen Centre of Excellence (Worley)**

## 2.5 Concrete building blocks for the COPE ecosystem

Over the period 2026-2027, COPE's activities will result in a number of concrete outputs, constituting the foundations for a better-functioning electrolysis testing ecosystem.

Together, these deliverables represent the first concrete step towards an integrated, more efficient and more accessible electrolysis testing ecosystem.

### 2 broadly supported protocols

When it comes to testing protocols, this will lead to a set of selected, experimentally validated test methods. The aim is to deliver at least two broadly supported protocols, including guidelines for their application. This will enable faster and more comparable performance and degradation assessment.

### 10 test cases for standardisation

The first building blocks of an operational network will be developed for the Distributed Test Center. This will include a standardised intake and routing process, results from a pilot involving approximately 10 test cases and an initial set of KPIs related to lead time and user satisfaction. In addition, a decision-making model will be developed to match testing requests to the most suitable facility and scale.

### Capability map

COPE will also deliver a capability map: an overview of testing and modelling capacities, classified by technology, scale and application. This will be key to effectively routing testing requests within the network. A first overview is in chapter 3 of this paper.

### Conceptual design for intelligent platform

For the Electrolyser Intelligence Platform, the focus will be on a conceptual design, including use cases and a development roadmap. Particular attention will be paid to means of leveraging existing knowledge and data without requiring direct data sharing.

### Governance and legal framework

Finally, a governance and legal framework will be developed, including agreements on participation, intellectual property and data use. In parallel, work will be carried out on European positioning, including organising an international alignment workshop and the development of a relevant partner network.

> The COPE provides a great opportunity to connect parties across the hydrogen value chain and in this way helps us define the relevant academic research questions, ensuring that we carry out 'science for society'
>
> **Thijs de Groot, Professor Electrochemical Engineering (Eindhoven University of Technology)**

# 3

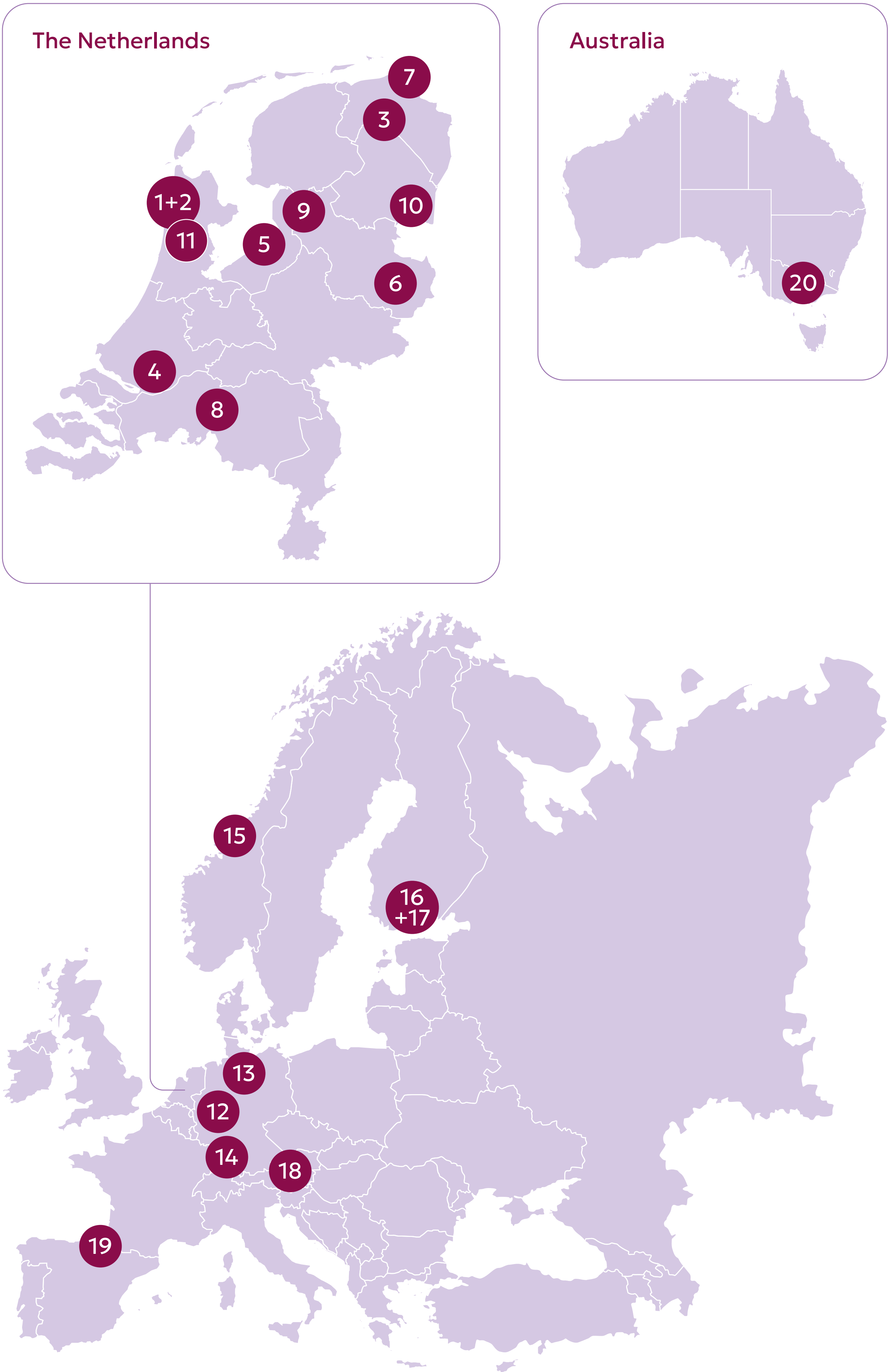
# The electrolysis testing landscape: an overview

Insights into the existing testing facilities, capabilities, scales and technologies

# 3. The electrolysis testing landscape: an overview

To better understand the current electrolysis testing landscape, it is essential to gain insight into the existing facilities, capabilities and gaps across scales and technologies. The overview below provides a first, non-exhaustive inventory of known testing locations in the Netherlands and abroad. It is a live list and additions or corrections are welcome.

1. Faraday Lab
2. JRC Petten Electrolyser and Fuel Cell Testing Facility
3. Hydrohub MegaWatt Test Center
4. FieldLab Industrial Electrification
5. SWITCH Fieldlab
6. The Green Box
7. DOT Phynix/ Base Load Power Hub
8. Bosch Energy Conversion Campus
9. ROGER Waterstof Onderzoek, Test en Productiefaciliteit (OTP)
10. Electrolyser durability test facility
11. InVesta – Energy Innovation Park Alkmaar
12. Forschungszentrum Jülich GmbH
13. Fraunhofer IWES– Bremerhaven and Hydrogen Lab Leuna (HLL)
14. Fraunhofer ISE – Electrolysis Laboratory
15. SINTEF Low Temperature Electrolysis & Fuel Cell Laboratory
16. VTT – SOC Laboratory
17. VTT – Low Temperature Laboratory
18. HyCentA Research GmbH
19. TECNALIA – Hydrogen Technologies Laboratory / Electrolysis manufacturing and test benches
20. CSIRO Hydrogen Technology Demonstration Facility (HTDF)


The Netherlands
7
3
1+2
9
10
11
5
6
4
8
Australia
20
15
16
+17
13
12
14
18
19

# 1. Faraday Lab

High-quality electrochemical diagnostics and open-innovation collaboration for supply-chain partners with a strong focus on cost reduction, durability and scalability.

**Location:** Petten, the Netherlands

**Scope & test levels:** Faraday Lab is an open-innovation R&D facility focused on materials/components, cells and (short) stacks, supporting performance testing, validation and optimisation of new membranes, electrodes, catalysts, coatings and cell architectures.

**Technologies:** PEM, AEM, AWE, SOE

**Scale:** up to approximately 50 kW and large single-cell formats

**Aim:** to accelerate breakthroughs for electrolysis scale-up by removing technology barriers and enabling partners to test and translate component/cell learning to larger systems.


## 2. JRC Petten Fuel Cell and Electrolyser Testing Facility

Independent, pre-normative testing and a pathway for trusted benchmarking and protocol validation under EU Open Access schemes.

**Location:** Petten, the Netherlands

**Scope & test levels:** independent testing infrastructure for single cells, short stacks, stacks and small systems, including environmental simulation capabilities (e.g. climate/vibration as described in open-access descriptions).

**Technologies:** low and high temperature electrolysis and fuel cell testing with focus on PEM technology

**Scale:** available stations for ~500 W for both low and high temperature testing. A 30 kW low-temperature electrolysis test bench for stack testing and protocol validation to be operational in 2026.

**Aim:** to provide evidence-based PNR testing to support harmonisation and standardisation activities for electrolyser and fuel cell. Special focus on performance/durability assessment and testing protocols validation, supporting EU hydrogen policy and comparability across labs.


# 3. Hydrohub MegaWatt Test Center

Unique open innovation MW testing environment where suppliers and OEMs can validate innovations beyond lab scale without being confined to OEM-only sites.

**Location:** Groningen, the Netherlands

**Scope & test levels:** semi-industrial, open-innovation testing centre focused on stack and system-level testing, including validation of components and materials under realistic operation.

**Technologies:** PEM and AWE are explicitly installed and used for research programmes

**Scale:** two 250 kW electrolysers (PEM + alkaline), i.e. approximately 0.5 MW total installed.

**Aim:** to stimulate learning about scaling up and identify operating windows/limitations using stress tests and dynamic operation, supporting pathways toward GW-scale design, and to train on electrolyser technology and operation.

# 4. FieldLab Industrial Electrification (FLIE)

An open innovation platform for validating technologies before further scale-up and deployment at customer sites.

**Location:** Rotterdam, the Netherlands

**Scope & test levels:** industrial fieldlab for testing, validating and demonstrating at first relevant industrial scale, of electrification technologies, including Power to Hydrogen (electrolysers). It offers an open innovation platform, practical location with suitable infrastructure and permitting in place. This way creating an integrated industrial chain (system level) for end-users, energy companies and technology companies to cooperate, and transition towards sustainable, electrified processes.

**Technologies:** Power-to-X broad; electrolyser technology type (PEM/AEM/AWE/SOE) agnostic in 100's of kW scale

**Scale:** industrial relevant scale demonstrations connected to FLIE infrastructure; numeric kW/MW depends on the specific pilot line and project

**Aim:** to de-risk and accelerate implementation of electrification and Power to X conversion technologies by providing a place to validate innovations in an industrial environment, infrastructure and practical support.

# 5. SWITCH Fieldlab

"From solar panel to hydrogen tractor" validation-partners can run real-world simulations and validate their technologies in an operational microgrid with strong modelling linkage. Developments and demonstrations of EMS and cyber security innovations are part of the proposition.

**Location:** Lelystad, the Netherlands

**Scope & test levels:** system-level fieldlab integrating wind, solar, battery and an electrolyser to test control strategies, flexibility, microgrid operation and grid interaction.

**Technologies:** PEM

**Scale:** operates in a 25–60 kW power range for the integrated system

**Aim:** to provide a realistic, scaled environment to test integrated renewable generation, conversion and storage including a TNO Energy Management System, supporting solutions for grid congestion and system stability. The fieldlab has a weak grid emulator for real world demonstrations.


# 6. The Green Box

The Green Box is a cutting-edge cleantech campus where Plug Power drives the future of green hydrogen. With advanced office, testing, and production spaces, it conducts real-time demos, PEM stack testing, and system assessments without disrupting operations. With the European hydrogen market rapidly expanding, The Green Box serves as Plug's regional innovation hub, giving the tools, space, and collaboration opportunities accelerating the development of next-gen hydrogen solutions.

**Location:** Hengelo, the Netherlands

**Scope & test levels:** The Green Box is a leading open innovation cleantech campus dedicated to advancing the future of energy transition. The campus provides office, testing, and production spaces, along with high-capacity energy infrastructure, shared by multiple complementary tenants. Within this environment, Plug Power is actively testing, developing, and showcasing its industry-leading PEM technology.

**Technologies & Scale:** since the 1 and 5 MW systems operate independently, Plug Power is able to conduct live demos without disrupting any ongoing activities. This valuable capability also supports Plug Power's next-generation advancements, including PEM stack testing, system integrity assessments, real-time operational analysis & trending, as well as pre-assessing in-situ simulations for units already installed at his global customer sites.

**Aim:** to facilitate real-time demonstrations, customer interactions, and system enhance-ments. From research and development to operator training, this site serves as innovation hub, driving the future of the green hydrogen industry.


# 7. DOT – Phynix/ Base Load Power Hub

Realistic integrated operation for learning by doing on buffering, storage and system dynamics relevant to future energy hubs and a catalyst for collaboration.

**Location:** Eemshaven, the Netherlands

**Scope & test levels:** integrated system platform combining sea water desalination, electrolysis, hydrogen storage and battery buffering (system level) intended for research/learning and collaboration.

**Technologies:** PEM

**Scale:** a 2.5 MW electrolyser, battery storage (1 MW/5 MWh) and 1200 kg hydrogen storage

**Aim:** to generate deeper insights into renewable hydrogen production and storage in an offshore-designed integrated platform context as well as enable wide-ranging collaboration.

# 8. Bosch Energy Conversion Campus (under development)

Co-location of industry, applied research and education to speed up scale-up, manufacturability and deployment of energy conversion technologies.

**Location:** Tilburg, the Netherlands

**Scope & test levels:** Bosch in Tilburg is the pre-development centre of hydrogen electrolysis stacks within Bosch. Additionally, it is the ambition to start a campus environment at the Bosch premises to enable an open innovation ecosystem for research, development and industrialisation of energy conversion technologies across the full value chain, i.e. primarily manufacturing, system integration and industrialisation, complemented by lab/test facilities on site.

**Technologies:** explicitly broader than hydrogen; includes conversion toward hydrogen, CO, methane and other sustainable chemicals

**Scale:** 100's of kW scale

**Aim:** to bridge scientific discovery and industrial application, accelerate industrialisation of P2X technologies and practical implementation across the value chain.

**Targeted opening:** around 2027


# 9. ROGER Waterstof Onderzoek, Test en Productiefaciliteit (OTP)

An integrated hydrogen production and testing facility at the Marknesse site, combining hydrogen production with a flexible field lab for validating hydrogen technologies under realistic operating conditions. The field lab enables stress and endurance testing of electrolysers, fuel cells, hydrogen engines and related systems, supported by shared hydrogen storage (10,000–15,000 kg), safety infrastructure and utilities.

**Location:** Marknesse, the Netherlands (NLR campus)

**Scope & test levels:** ROGER Renewable Energy and Royal Netherlands Aerospace Centre are developing an integrated hydrogen production and testing facility at the Marknesse site, combining hydrogen production with a flexible field lab for validating hydrogen technologies under realistic operating conditions.

**Technologies:** electrolyser-based hydrogen production and testing concept

**Scale:** the production facility is designed with an initial electrolysis capacity of 5–10 MW, scalable under the current grid connection (ATO) to 20 MW. Approximately 5 MW flexible capacity can be allocated to field-lab activities. The site provides direct access to hydrogen production, compression, storage and safety infrastructure, including a central storage capacity of approximately 10,000–15,000 kg hydrogen, enabling testing from kW to multi-MW scale.

**Aim:** to accelerate technology validation, reduce scale-up risks and support industrial deployment of hydrogen applications. The field lab is intended for stress testing, endurance testing and validation of hydrogen-related equipment, including electrolysers, stacks, fuel cells, hydrogen internal combustion engines (HICE), compression systems and technologies for hydrogen derivatives.

**Targeted opening:** mid 2027

## 10. Electrolyser durability test facility

A key gap at higher Technology Readiness Levels (TRL 7–9) is the availability of facilities for long-duration testing and large-scale demonstration. To address this, GroenvermogenNL, TNO, DNV and Shell are jointly developing a dedicated electrolyser durability test facility in Emmen, the Netherlands. The facility will focus on long-term performance testing of electrolysis systems in the 1 to 10 MW range, supporting the final phase of innovation where technologies must demonstrate reliability, safety and bankability under (semi-)commercial conditions.

**Location:** Emmen, the Netherlands

**Scope & test levels:** demonstration, certification and de-risking at stack, BoP and full system level with industrial relevant conditions set by end users

**Technologies:** AEM, SOE, AWE, PEM

**Scale:** 2-10 MW

**Aim:** to facilitate long duration testing and large-scale demonstration

**Targeted opening:** Q2 2028

# 11. InVesta – Energy Innovation Park Alkmaar (including PosHYdon onshore test location)

A ready-to-use site with utilities, space for demo/testing installations, office/meeting/lab facilities and site support, enabling faster and more cost-effective experimentation and scale-up plus proven capability as an onshore test location for high-profile hydrogen pilots.

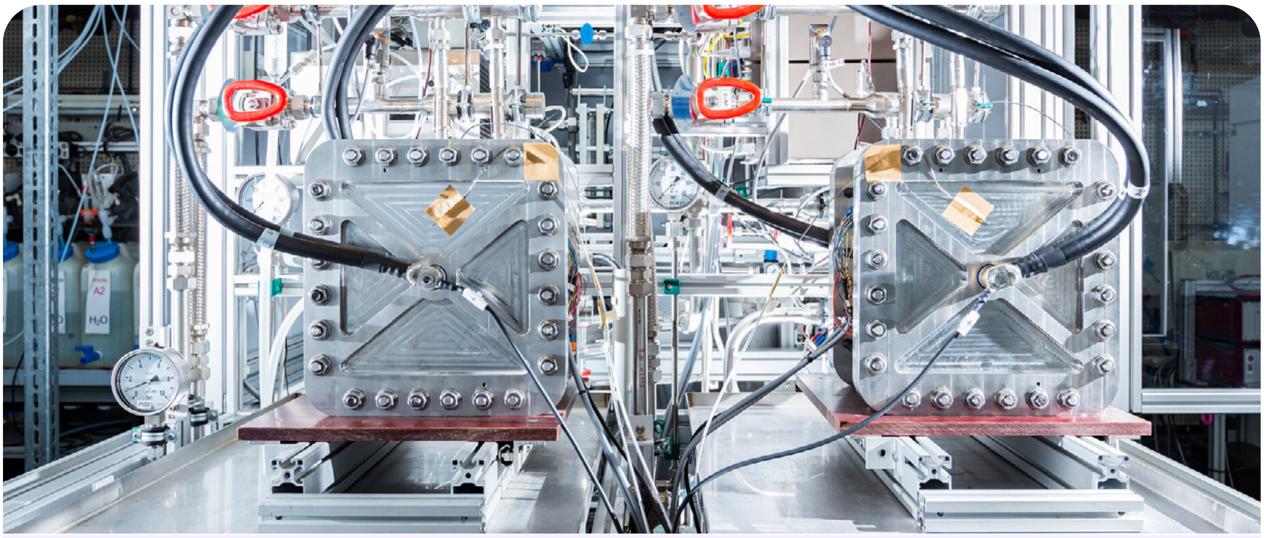
**Location:** Alkmaar, the Netherlands

**Scope & test levels:** InVesta is a field lab/expertise centre for 'sustainable molecules' where companies, researchers and the government collaborate. It features facilities (lab, technical infrastructure and space) for developing and testing technologies in the hydrogen, green gas and related gas technologies domain.

**Technologies:** technology wide (hydrogen, green gas, biofuels/sustainable molecules). PosHYdon's onshore integration test took place at InVesta before offshore installation, indicating capability to host system-level integration and commissioning tests for an electrolyser-based pilot. A next demonstration is planned coming year by the Berlin Company Stoff2 to test a smart small scale electrolyser at InVesta as part of the EU project Reformers.

**Scale:** availability of space and utilities suitable for demonstration/testing installations and fast-track permitting support

**Aim:** to provide an accessible innovation environment to accelerate the development and validation of technologies that produce and use sustainable molecules, and to act as a collaboration hub where innovations move from lab phase into demo/market readiness.



# 12. Forschungszentrum Jülich GmbH

A uniquely instrumented, real-stack environment enabling high-resolution insight into degradation mechanisms under realistic dynamic operation.

**Location:** Jülich, Germany

**Scope & test levels:** DERIEL provides a testing facility for real industrial PEM stacks at MW-scale with continuous monitoring using advanced sensor technology, combined with extensive post-mortem analysis and modelling.

**Technologies:** explicitly PEM (facility built for PEM electrolysis stacks/modules in DERIEL context)

**Scale:** MW-range (full-size, industrial-scale) stack testing

**Aim:** to understand ageing/degradation and improve cost and lifetime as well as feed that which has been learned back into next-generation electrolyser designs and supporting the competitiveness of 'made in Germany' electrolysers.

# 13. Fraunhofer IWES– Bremerhaven and Hydrogen Lab Leuna (HLL)

Industrial integration in a chemical park with supply media and pipeline feed-in context (Leuna) and wind energy (Bremerhaven), enabling realistic system validation and scale-up learning.

**Location:** Bremerhaven, Bremen, and Leuna Chemical Park, Saxony-Anhalt, Germany

**Scope & test levels:** system-level testing up to 5 MW and also stack/component testing up to ~50 kW, with 24/7 operation and dynamic load profile simulation for durability and stress testing. Advance integration with wind energy.

**Technologies:** PEM, AEL/AWE, AEM, SOEC

**Scale:** up to 5 MW for industrial electrolyser systems; up to 50 kW for stack/component rigs.

**Aim:** to validate performance, cost-efficiency and long-term behaviour under real-world/dynamic operation and to generate data supporting future certification and reliability assurance.

# 14. Fraunhofer ISE – Electrolysis Laboratory

High-fidelity diagnostics and materials/component expertise for PEM/AEM, closely linked to industrial implementation pathways.

**Location:** Freiburg im Breisgau, Germany

**Scope & test levels:** Fraunhofer ISE's electrolysis lab focuses on PEM and AEM water electrolysis, including cell and stack design, short-term electrochemical testing and long-term durability studies. It also supports monitoring of electrolysis systems.

**Technologies:** PEM and AEM explicitly

**Scale:** cell/stack research.

**Aim:** to understand and mitigate ageing mechanisms, develop rapid ageing tests and support industrialisation of MEA manufacturing and component optimisation.

## 15. SINTEF Low Temperature Electrolysis & Fuel Cell Laboratory

Highly customisable testing stations plus strong analytical capability linking performance/degradation to gas/water quality.

**Location:** Trondheim, Norway

**Scope & test levels:** SINTEF's low-temperature hydrogen lab offers single cell testing up to kW-scale short stacks, with dedicated electrolysis stations for PEM single cells and stacks, plus high-pressure alkaline single cell/short stack capability.

**Technologies:** PEM electrolysis (single cell & stack) and high-pressure alkaline (single cell/short stack).

**Scale:** R&D-scale single cells to kW-scale short stacks.

**Aim:** to validate materials/components and perform lifetime/degradation studies under real-world and industrially relevant conditions with advanced analytics (GC, FTIR, ion chromatography).

## 16. VTT – SOC Laboratory

Highly instrumented reliable characterization platforms allowing tailored experimental campaigns.

**Location:** Espoo, Uusimaa, Finland

**Scope & test levels:** specialized in short stack, full stack and module characterizations to support technological development in component and system level. Infrastructure also allows development support via industrial single cell characterizations and material exposure campaigns.

**Technologies:** SOC (EL, FC, and reversible)

**Scale:** from industrial single cell test benches to stack test benches with capacity up to 60 kW. Also allowing larger demonstrations up to MW scale.

**Aim:** to support stack, component and technology developers or end-users to characterize products to allow upscaling towards industrial systems.

# 17. VTT – Low Temperature Laboratory

Fully automated, data-intensive and precision-monitored platforms allowing characterization oriented for specific customer needs.

**Location:** Espoo, Uusimaa, Finland

**Scope & test levels:** low temperature electrolysis laboratory is an R&D facility specialising in full stack characterisation, both small and large stacks, and system development. The infrastructure supports stack performance testing, validation and system optimisation together with BoP characterisation.

**Technologies:** PEM, Alkaline, AEM

**Scale:** from industrially relevant stack test stations to containerised solutions with capacity up to 50 kW. It also allows MW-scale system demonstrations.

**Aim:** to support stack developers and industrial customers by evaluating different technology platforms and allowing upscaling towards larger industrial systems.

# 18. HyCentA Research GmbH

Independent research institute focused on hydrogen technologies, providing testing and development services for fuel cells, electrolysers and hydrogen components, embedded in a comprehensive hydrogen testing infrastructure and innovation ecosystem.

**Location:** Graz, Styria, Austria

**Scope & test levels:** hydrogen research centre with strong testing capabilities "all-in-one" test facility for PEM and AEM electrolyser testing (from cell over stack to system level), in a broader hydrogen technology testing context

**Technologies:** PEM and AEM for electrolyser testing. Test environments: multiple in-situ and ex-situ testing capabilities for performance, durability, degradation and efficiency characterisations

**Scale:**

- single cells up to 200A
- short-stacks from 2kW up to 160kW (and 10.000 A)
- full size MW-stacks and systems up to 1,5 MW

**Aim:** to provide advanced testing infrastructure to accelerate R&D and validation for hydrogen technologies, including electrolysis testing from cell over stack to system level, with robust test methodologies.

# 19. TECNALIA – Hydrogen Technologies Laboratory / Electrolysis manufacturing and test benches

Advanced manufacturing, applied testing and modelling and validation with direct linkage to industrial deployment challenges.

**Location:** San Sebastián, Basque Country, Spain

**Scope & test levels:** test capability spanning electrochemical characterisation (materials/ electrodes/membranes), MEA testing, and stack testing. From small-scale up to ~50 kW designed to test stack and BoP components under different operating conditions.

Manufacturing and assembly of stack and its key components by dedicated pilot line for low temperature electrolysis (AEM/PEM/AEL).

**Technologies:** AEM/PEM/AEL/SOEC.

**Scale:** small-scale up to ~50 kW

**Aim:** to provide companies an experimental platform to validate components (stack + BoP) and accelerate industrialisation of electrolyser technologies.

# 20. CSIRO Hydrogen Technology Demonstration Facility (HTDF)

De-risked scale-up through practical hydrogen engineering, strong safety and HAZOP support, onsite technical support, and an established demonstration environment that helps innovators move from benchtop development to pilot and commercially relevant validation.

**Location:** Clayton, Australia

**Scope & test levels:** The CSIRO Hydrogen Technology Demonstration Facility (HTDF) is a multi-user hydrogen technology demonstration and scale-up facility that enables industry and researchers to test and demonstrate hydrogen technologies in a controlled, safety-led environment. The facility supports system- and subsystem-level work across hydrogen production, electrolysis-related demonstrations, separation and processing, storage, refuelling and utilisation. Its common-use infrastructure includes seven fully equipped research bays, renewable energy supplied via power purchase agreement, a hydrogen refuelling station with an electrolyser and 80 kg of hydrogen storage, a cryogenic research facility, and safety systems including hydrogen sensing and venting. Each bay is equipped with single- and three-phase electricity, deionised water, piped gases, alarms and hydrogen venting.

**Technologies:** multi-technology including a hydrogen refuelling station with an electrolyser and approx. 80 kg storage

**Scale:** pilot-scale testing, such as demonstrating technology that can produce around 4,7 kg of hydrogen per day.

**Aim:** to help innovators move from benchtop to pilot/commercially relevant scale in a controlled environment, enabling demonstrations to investors/buyers/regulators.

# 4

# Conclusion and invitation

Contribute with experience, facilities or challenges and help build the international ecosystem

# 4. Conclusion and invitation

Now is the time to turn shared ambition into shared action. TNO and GroenvermogenNL invite the industry, testing facilities, certifying organisations, knowledge institutes and policymakers to join COPE. Not as observers, but as contributors.

Participation is currently free of charge, as COPE is being developed as a research-driven initiative to help shape the ecosystem. From 2027–2028 onwards, a contribution-based and fee-for-service model is expected to be implemented to support long-term operations. Organisations that engage at this early stage may benefit in return for in-kind contributions. Priorities within the programme scope will be determined in part by the contributions of participating organisations, including financial support, in-kind contributions and the sharing of relevant data and information.

**By becoming part of this community, you will help to:**

- Harmonise testing and accelerate the development of reliable, comparable protocols.
- Strengthen the testing ecosystem so every company knows what to test, where, when and at which scale.
- Unlock collective learning with privacy-preserving technology.
- Contribute with your experience, your facilities, your challenges and help build the strong, coherent and efficient testing ecosystem that Europe needs to scale electrolysis.

Visit **our website** for further details on how to join.

> ‘As a technology provider of MEAs for PEM water electrolysis, Toshiba values being part of this community as it enables fair, cross-border evaluation based on objective technical merit. Common benchmarks help ensure that strong and commercially ready technologies, including our low-iridium MEAs, are properly recognized beyond regional differences.’
>
> **Kazuto Hasebe, General Manager Hydrogen Business Development (Toshiba)**

**This publication is a collaborative effort by GroenvermogenNL and TNO.**


This publication was written and edited by Tara van Abkoude (TNO) and Liesbeth Looman (GroenvermogenNL). Thanks to Ed Buddenbaum, Arend de Groot, Jochen Loffler and Jörg Gigler for their cooperation.

COPE | Community of Practice Electrolysis

**Test. Learn. Scale. Together.**