

Standardization and protocol development for High-Temperature Electrolysis



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Benchmarking & Protocols Workshop**

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- Short introduction to Kiwa: global, hydrogen and industry
- The role of regulations, codes and standards
- Key electrolyser protocols
- Test protocols – the new frontier
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This is **what we do** at Kiwa

Creating trust, driving progress. That's what we do for our customers.
We support our core activities with three additional activities.



Testing



Inspection



Certification



Training



Consultancy



Data Services

We operate fully independently and impartially. Therefore, we strictly separate our certification, testing and inspection services from adjacent activities like offering training courses, consultancy and data-related or data-driven services.

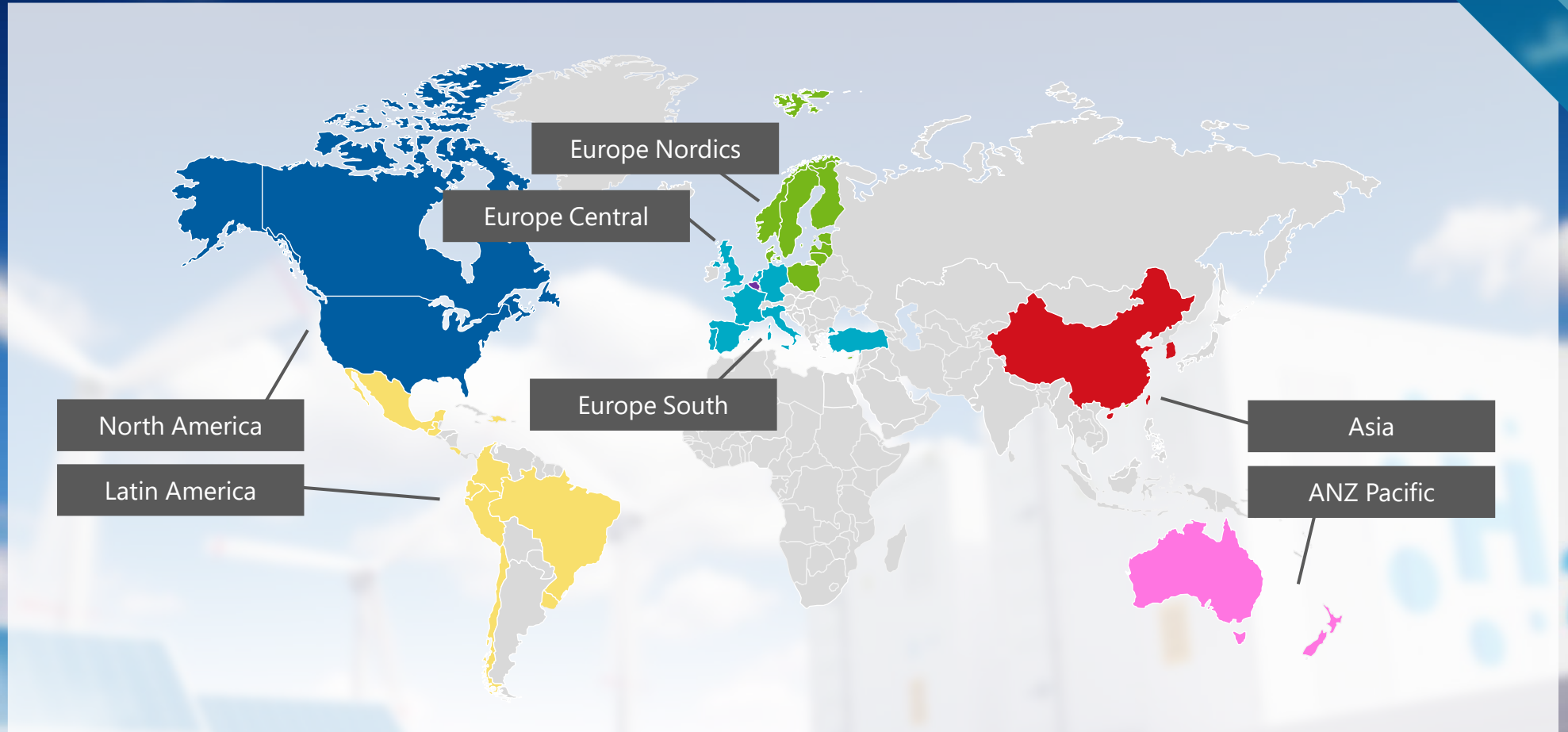
This is who and where we are today



Globally active,
locally available

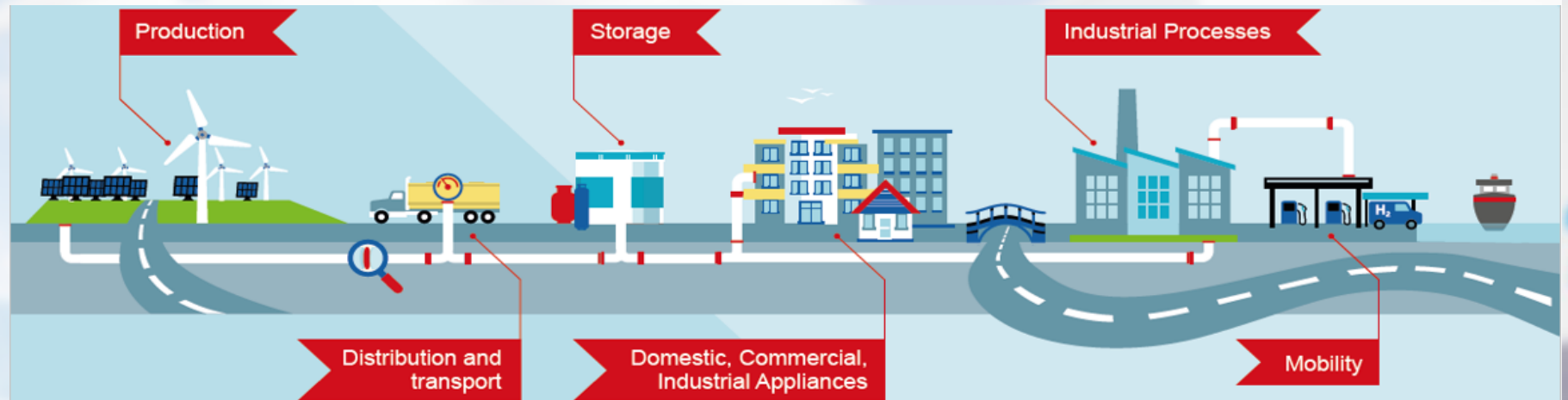


> 10k experts

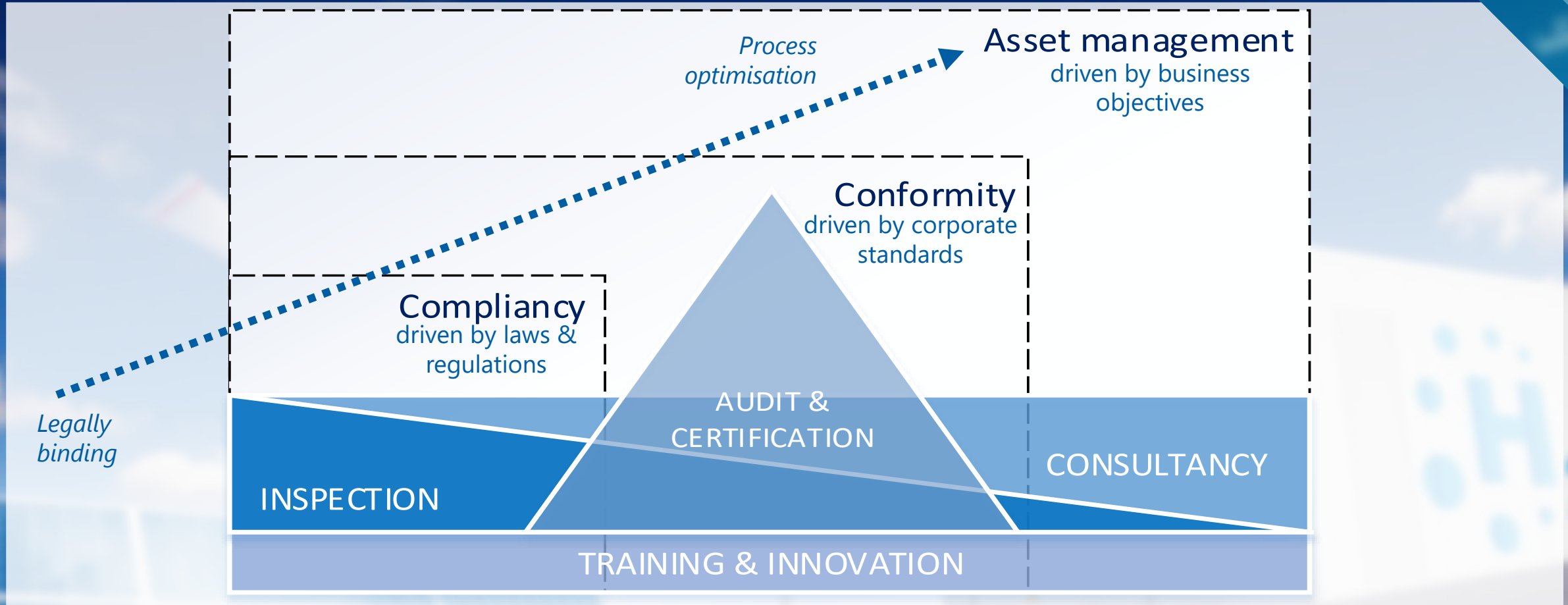


Your partner in the **hydrogen sector**

- State of the art hydrogen laboratories
- One-stop-shop for testing, inspection, certification and consultancy
- For all parts of the hydrogen supply chain
- In all phases of industrial project development
- Global player



Kiwa – from NoBo to knowledge partner



...from component sourcing to consumer off-take

Economic directives

Social & Local directives

PRODUCT

WORKPLACE

COMPONENT EQUIPMENT ASSEMBLY

INSTALLATION 



local legislation

RISK ANALYSIS

E P

C

		Potential Consequences					
		LC	LS	LD	LI	LT	
		Minor injuries or discomfort. No medical treatment or reasonable physical effects.	Injuries or illness requiring medical treatment. Temporary impairment.	Injuries or illness requiring hospital admission. Temporary impairment.	Injury or illness resulting in permanent impairment.	Fatality	
		Not Significant	Minor	Medium	Major	Severe	
Likelihood	Expected to occur regularly under normal circumstances	Almost Certain	Medium	High	Very High	Very High	Very High
	Expected to occur at some time	Likely	Medium	High	High	Very High	Very High
	May occur at some time	Possible	Low	Medium	High	High	Very High
	Not likely to occur in normal circumstances	Unlikely	Low	Low	Medium	Medium	High
	Could happen, but probably never will	Rare	Low	Low	Low	Low	Medium

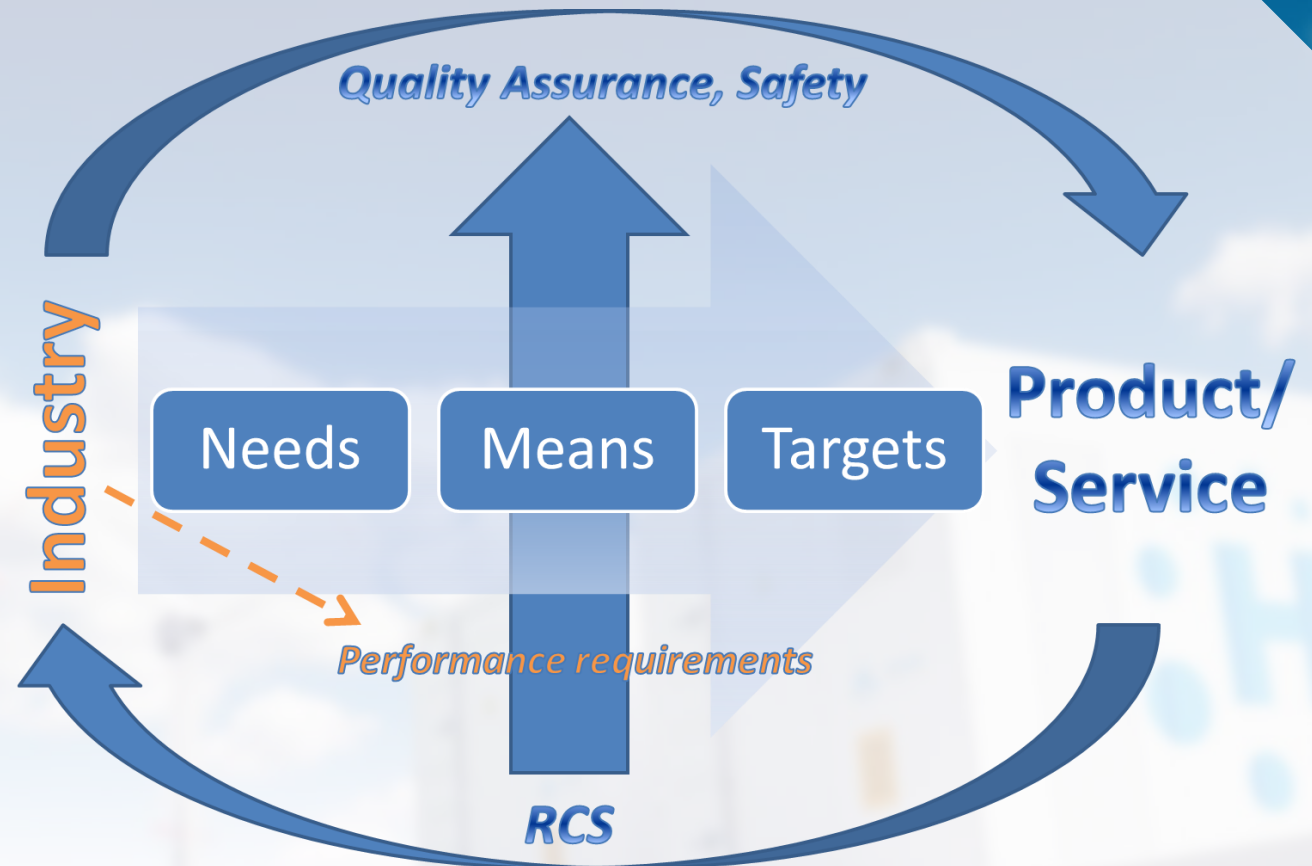


Quality & safety through Regulations, codes & standards

Regulations, codes and standards

(RCS):

- provide requirements (e.g. effectiveness, reliability) with regards to the means (e.g. procedures, prevention, mitigation) used to achieve performance/safety targets.
- provide design criteria ensuring fitness for purpose by relating requirements to conditions of use and accepted solutions for meeting the performance requirements or safety targets



Quality & safety through Regulations, codes & standards

Pre-Assessment (Design Phase)

- Identification of all applicable directives and relevant standards
- Review of the risk assessment
- Design Review

Pre-assessment
report

Costructural Review (Prototype phase)

- Component conformity
- Assessment of the functional safety
- Compliance with requirements

Test programme

Type Testing (Prototype phase)

- Tests at accredited facilities or at client's site in witness
- ISO 17025 accredited tests

Test report

Certificate(s) (Production phase)

- Certificate of "presumption of conformity"
- Certificate of compliance with NoBo-required directives

Certificate



Quality & safety through Regulations, codes & standards

Pre-Assessment (Design Phase)

- Identification of all applicable directives and **relevant standards**
- Review of the risk assessment
- Design Review

Pre-assessment
report

Which standards are relevant for electrolysers?

- **ISO 22734** ("Hydrogen generators using water electrolysis") and all normative references therein (e.g. on pressure vessels, hydrogen piping, safety of machinery, explosion safety etc.)
- **IEC 62282-8 series** ("Energy storage systems using fuel cells in reverse mode") insofar as they relate to electrolysis operation (not fuel cell operation)
- **European Commission JRC Method:** "EU harmonised testing protocols for high-temperature steam electrolysis"
- Any local/national standards/guidelines available

**High-temperature (steam)
electrolysis??**

Electrolyser test protocols

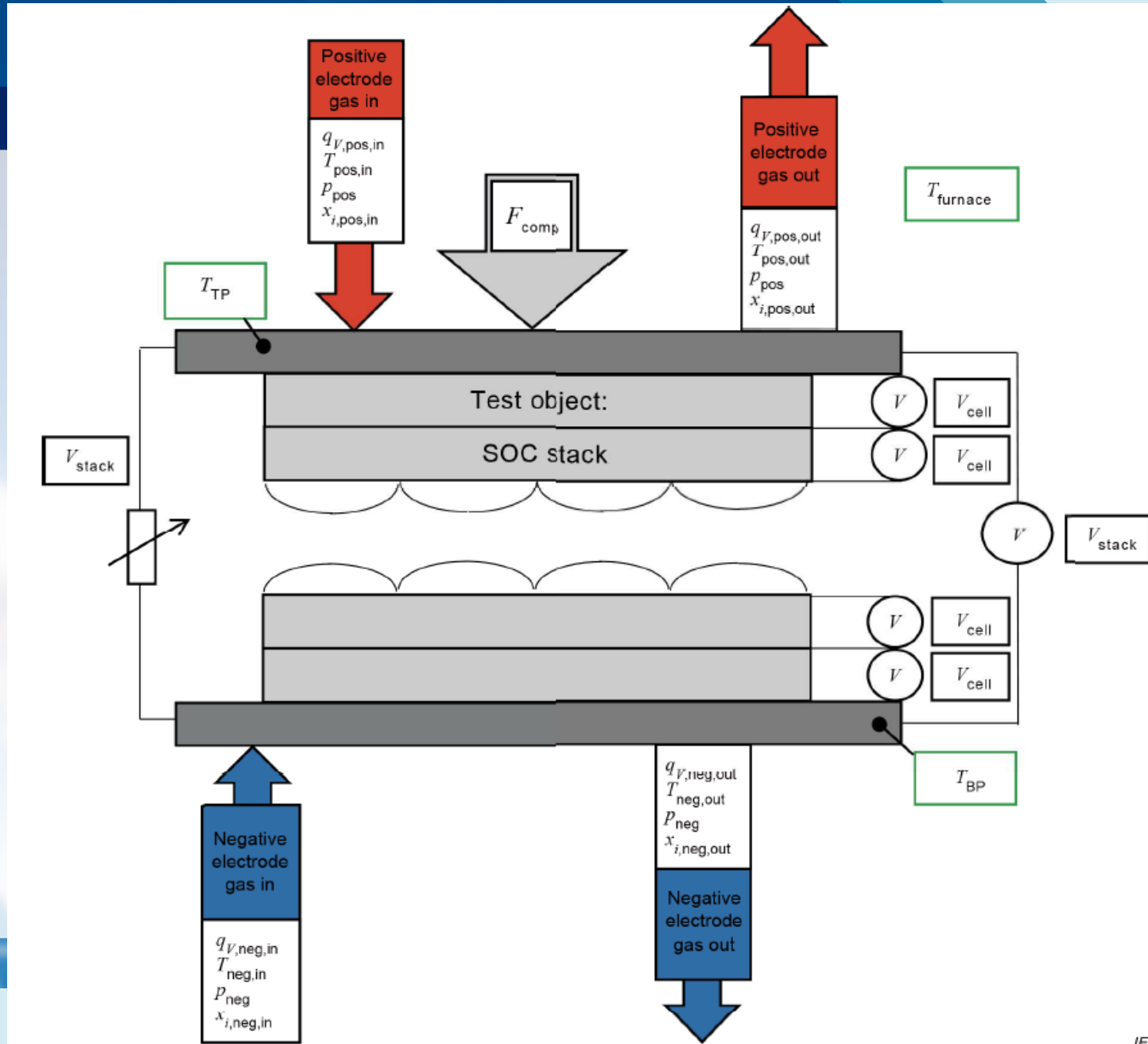
ISO 22734 (“Hydrogen generators using water electrolysis”)

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Electrolyser test protocols

IEC 62282-8-101 ("Energy storage systems using fuel cells in reverse mode – Test procedures for performance of **solid oxide cells & stacks** including reversible operation")

- NB. Other High-T Electrolysis technologies:**
- Molten carbonate electrolyte
 - Proton-conducting ceramics
- Similar features, different materials



Electrolyser test protocols

IEC 62282-8-101 (“Energy storage systems using fuel cells in reverse mode – Test procedures for performance of **solid oxide cells & stacks** including reversible operation”)

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Electrolyser test protocols

IEC 62282-8-101 ("Energy storage systems using fuel cells in reverse mode – Test procedures for performance of **solid oxide cells & stacks** including reversible operation")

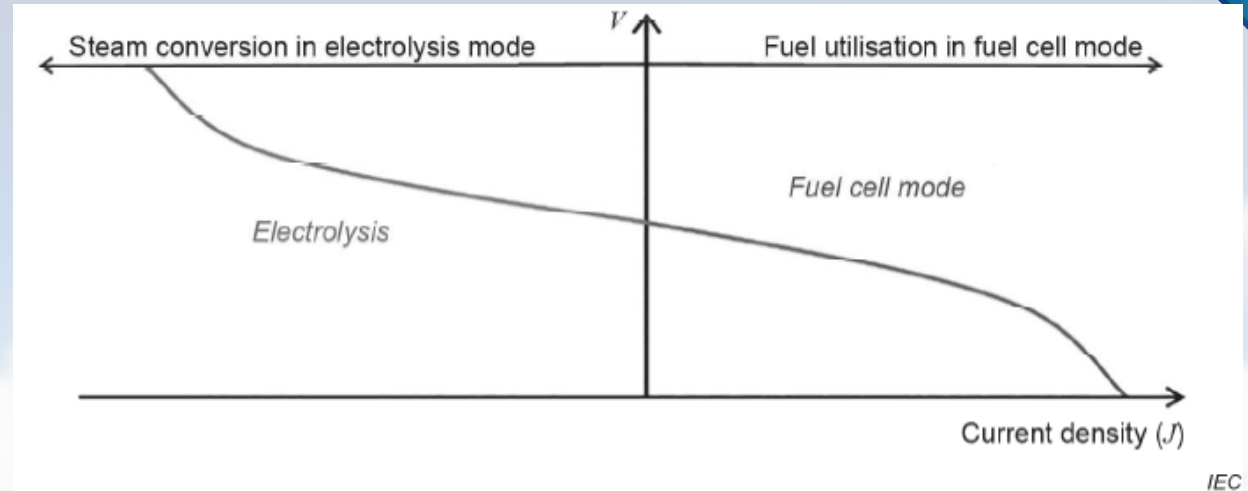
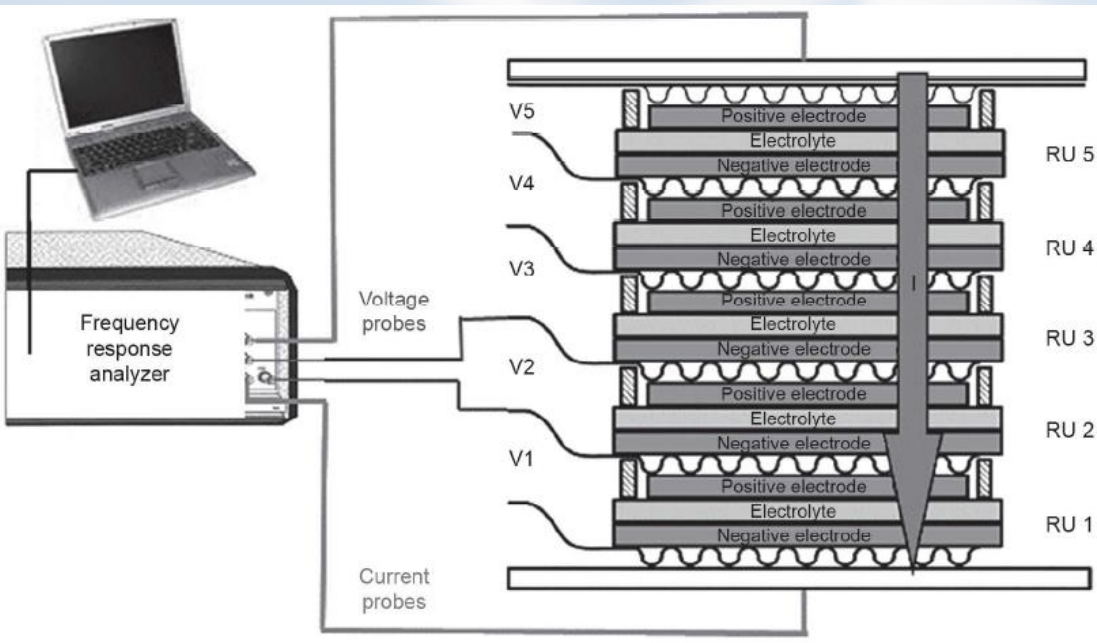
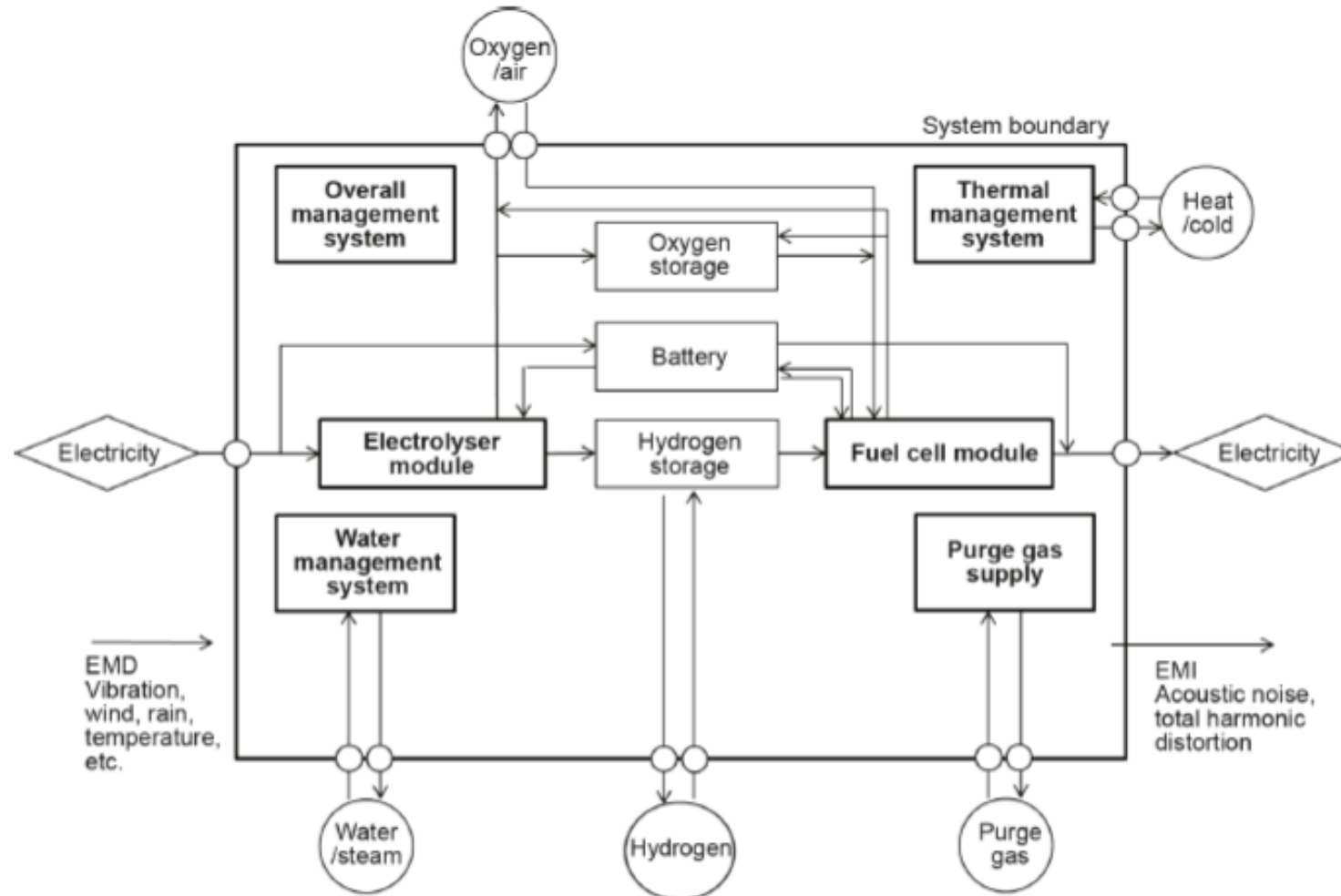


Figure A.3 – Schematic representation of a $J-V$ curve in both electrolysis and fuel cell modes

Electrolyser test protocols

IEC 62282-8-201 (“Energy storage systems using fuel cells in reverse mode – Test procedures for performance of **power-to-power systems**”)



Electrolyser test protocols

IEC 62282-8-201 (“Energy storage systems using fuel cells in reverse mode – Test procedures for performance of **power-to-power systems**”)

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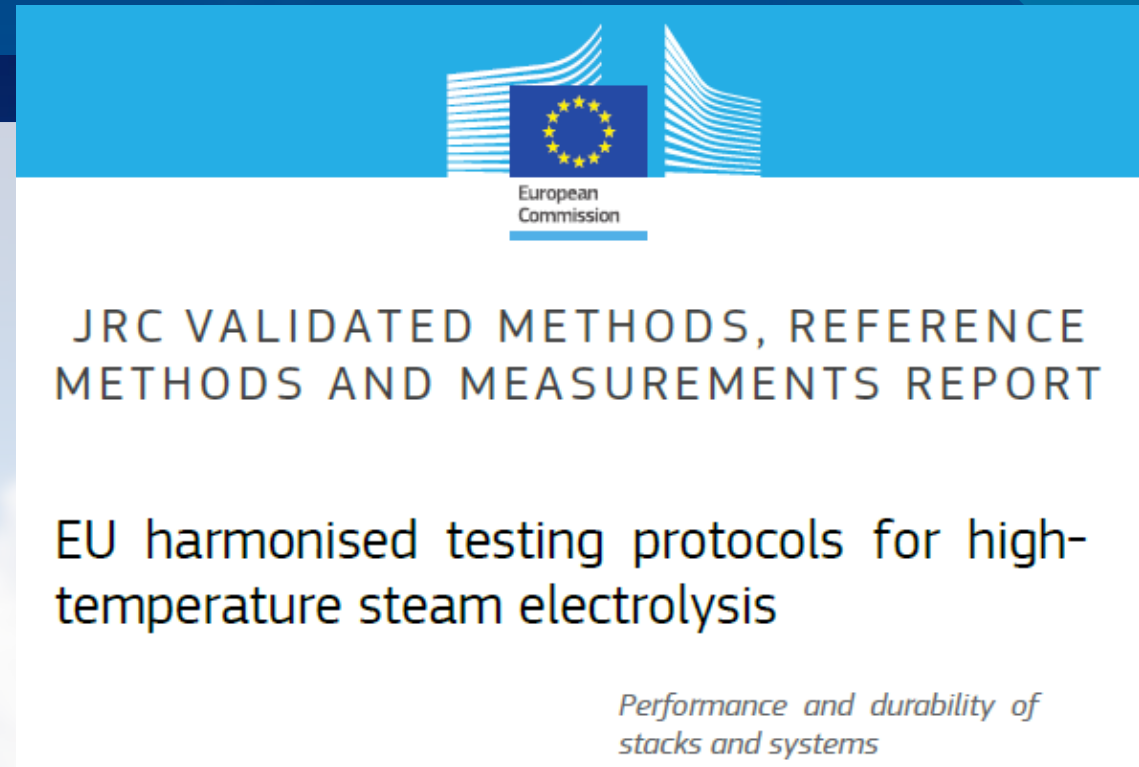
Electrolyser test protocols

European Commission JRC Method: “EU harmonised testing protocols for high-temperature steam electrolysis”

→ A comprehensive review and compound of protocols in the scientific, project-based and standardisation literature

Free download at:

https://www.clean-hydrogen.europa.eu/document/download/0f391a84-4fba-4873-bf81-4d514847cc6c_en?filename=EU%20harmonised%20testing%20protocols%20for%20high-temperature%20steam%20electrolysis%2C%20performance%20and%20durability%20of%20stacks%20and%20systems.pdf

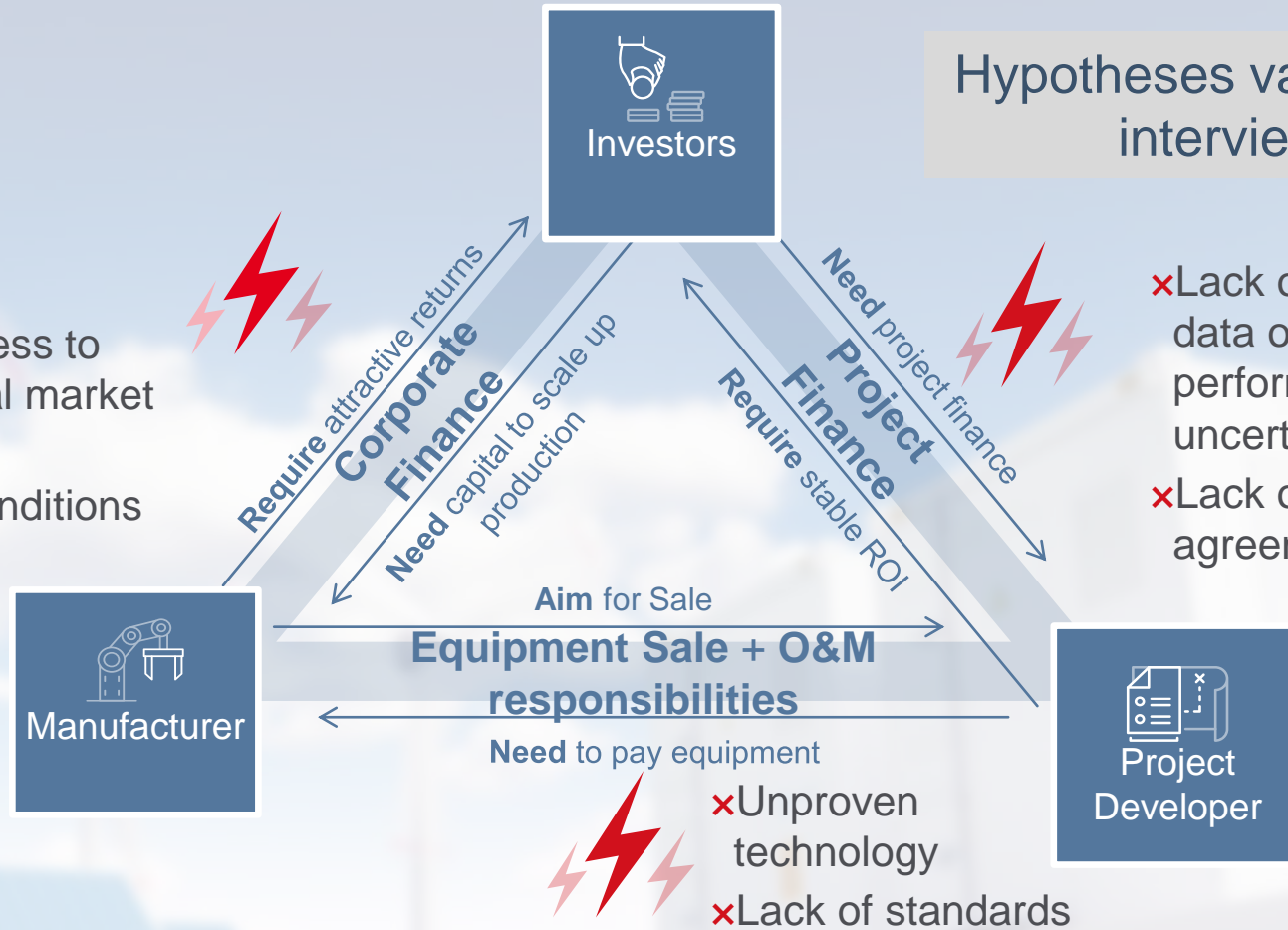


Electrolyser test protocols – the new frontier

High-temperature electrolysis:

- Achieve 80,000 h durability
- Provide robust technology for industrial processes and large projects: high liability
- **Need test protocols for accelerated performance & durability verification**

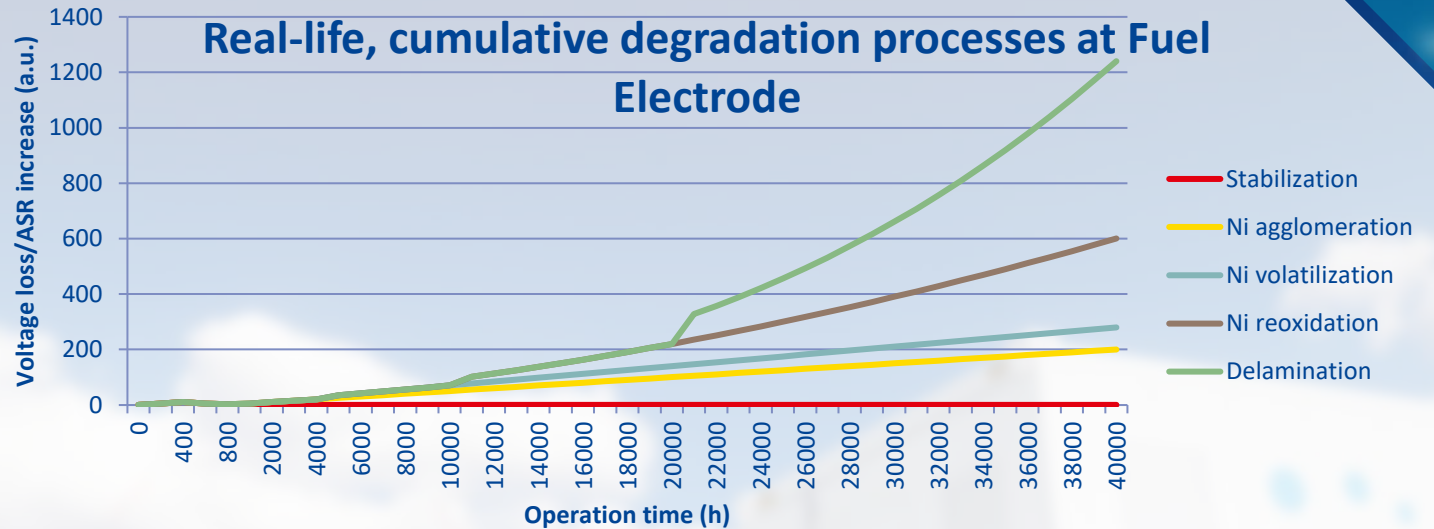
- ✗Lack of access to broad capital market
- ✗Unprofitable financing conditions



Electrolyser test protocols – the new frontier

Accelerated Stress Tests aim to:

- Design and verify component improvement with time/cost effectiveness
- Build reliable models for Remaining Useful Life prediction
- Improve stack/modules Diagnostics, Control and Real-Time Optimization hardware & software
- Provide the basis for reliable technology implementation



Ad hoc activity in IEC TC105:

- Review of technological bottlenecks & diagnostics
- Review of accelerated testing approaches
- Technical Report due to be published 2024

Kiwa references: **electrolysers**

BOSCH

COMATE

 John
Cockerill

 sunfire

 SolydEra

 PROTON
TECHNOLOGIES

 mitis

 GREEN
HYDROGEN
SYSTEMS

hydron

ANDRITZ

 stargate
hydrogen

EnTranCe
CENTRE OF EXPERTISE ENERGY

SOLENCO
POWER 

We
create
trust

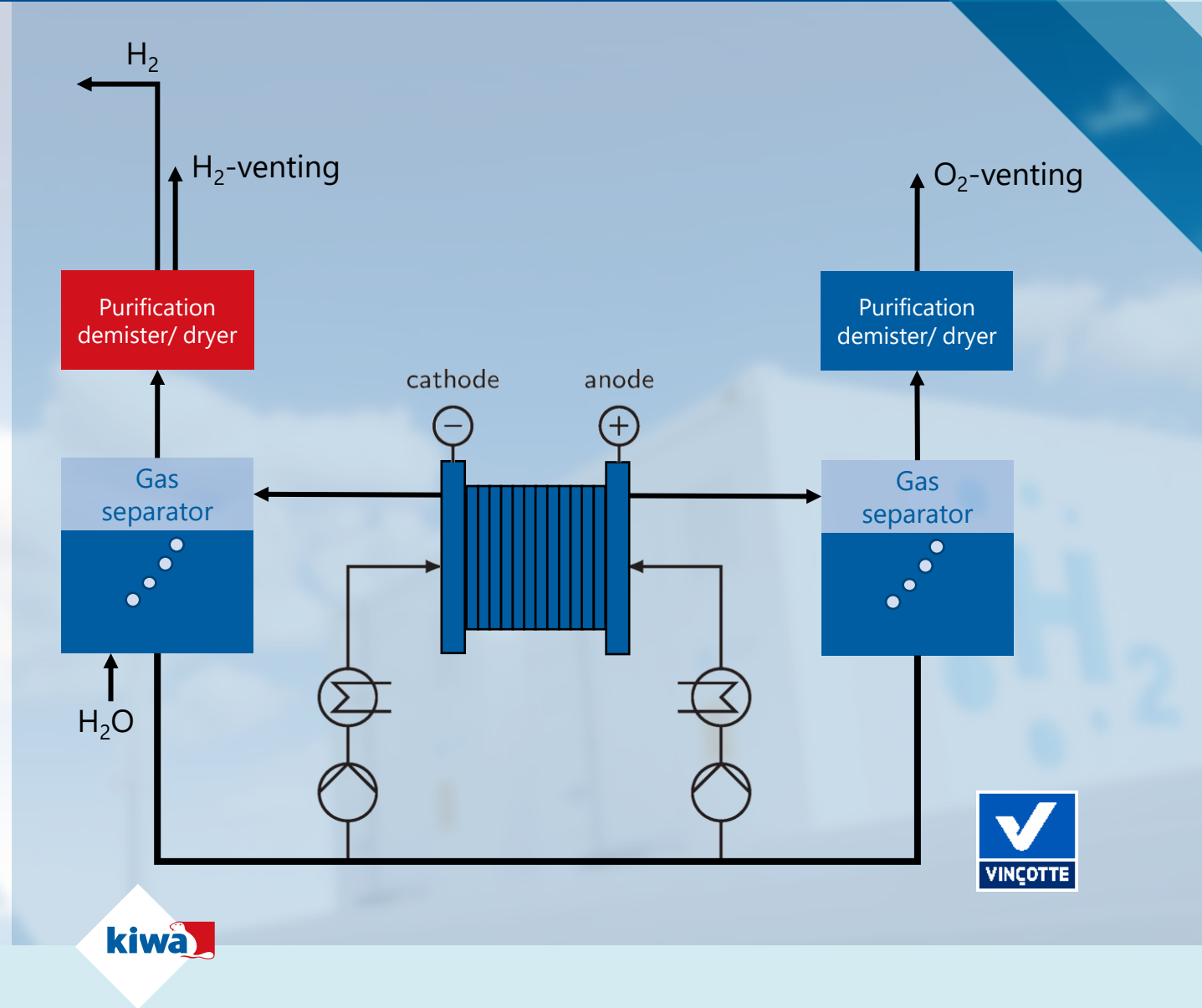


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Partner
for
Progress

Kiwa services and competences: **electrolysers**

- Support in alignment between stack suppliers
- Support / Assessment of risk assessments for electrolyzer design & integration
- Audits of suppliers & subcontractors according to relevant standards or Cepsa standard operating procedure (SOP)
- Electrolyzer testing in accredited labs (ISO 22734, IEC 62282) up to 200 kWe (40Nm³/h)
- Notified-Body services: certification of assemblies and components, inspections during installation and final documentation
- Installation approvals and inspections



Kiwa services and competences: electrolyser plants



- Bankability assessment
- High level risk assessments
- Support in plant integration philosophies, facility citing studies, ...
- Support/Assessment of risk assessments for plant integration
- Installation approvals and inspections
- O&M Readiness Plan for electrolyser plants

Interconnectivity creates new risks!

