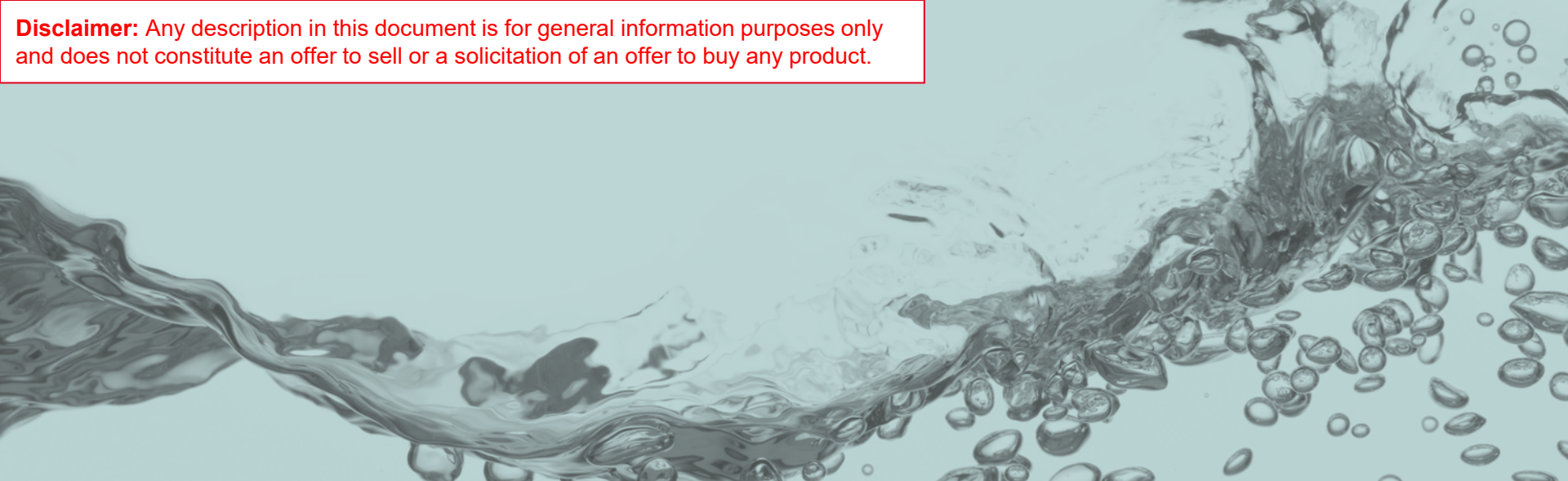


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Financing Green Hydrogen – Risks and the Role of Risk Transfer

May 2024

Dr. Kathrin Ebner | Emerging Green Tech Solutions | Munich Re



Munich Re Green Tech Solutions

For OEMs, Projects & Investors

Established



Solar

2009



Wind

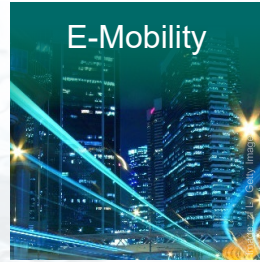
2009



ESS

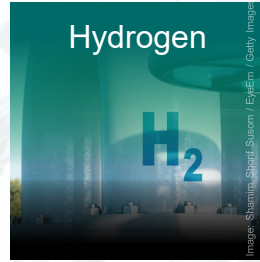
2019

Emerging



E-Mobility

2022



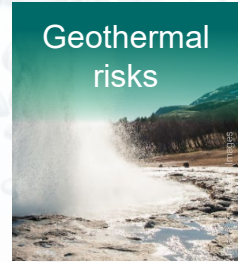
Hydrogen

2022



Circular Economy

2022



Geothermal risks

2023

Within Green Tech > 850 projects
with a nameplate capacity of ~ 51 GW
in ~ 80 countries.

Which Insights can I Expect Today?

- What are (technical) uncertainties associated with electrolysis at scale?
- Why do they impact hydrogen projects financially?
- How can risk transfer solutions act as an enabler in this context?

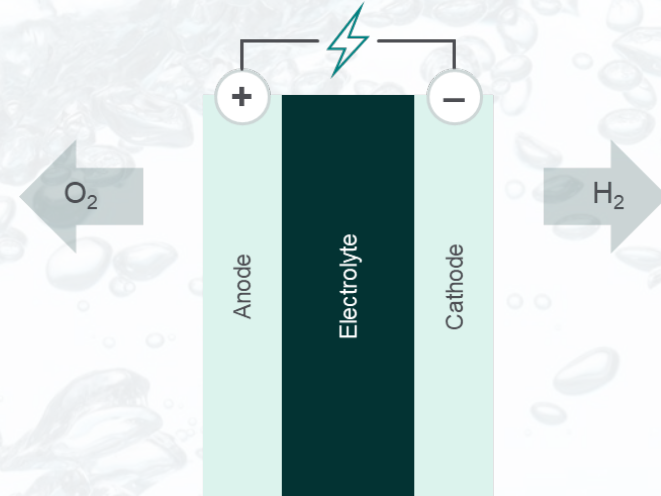
Green Hydrogen as an Energy Carrier: Motivation & Challenges

Large decarbonization potential

- Produced from renewables
- Intrinsically carbon-free
- Relatively versatile:
 - Direct use
 - Upgrading to other products
 - Re-electrification (mobile/stationery)
 - Longterm storage

Hurdles to overcome

- Drastic scale up of production capacity would be required
- Limited familiarity with technologies and risks involved



Uncertain and unproven technologies contribute to hesitance when it comes to investments

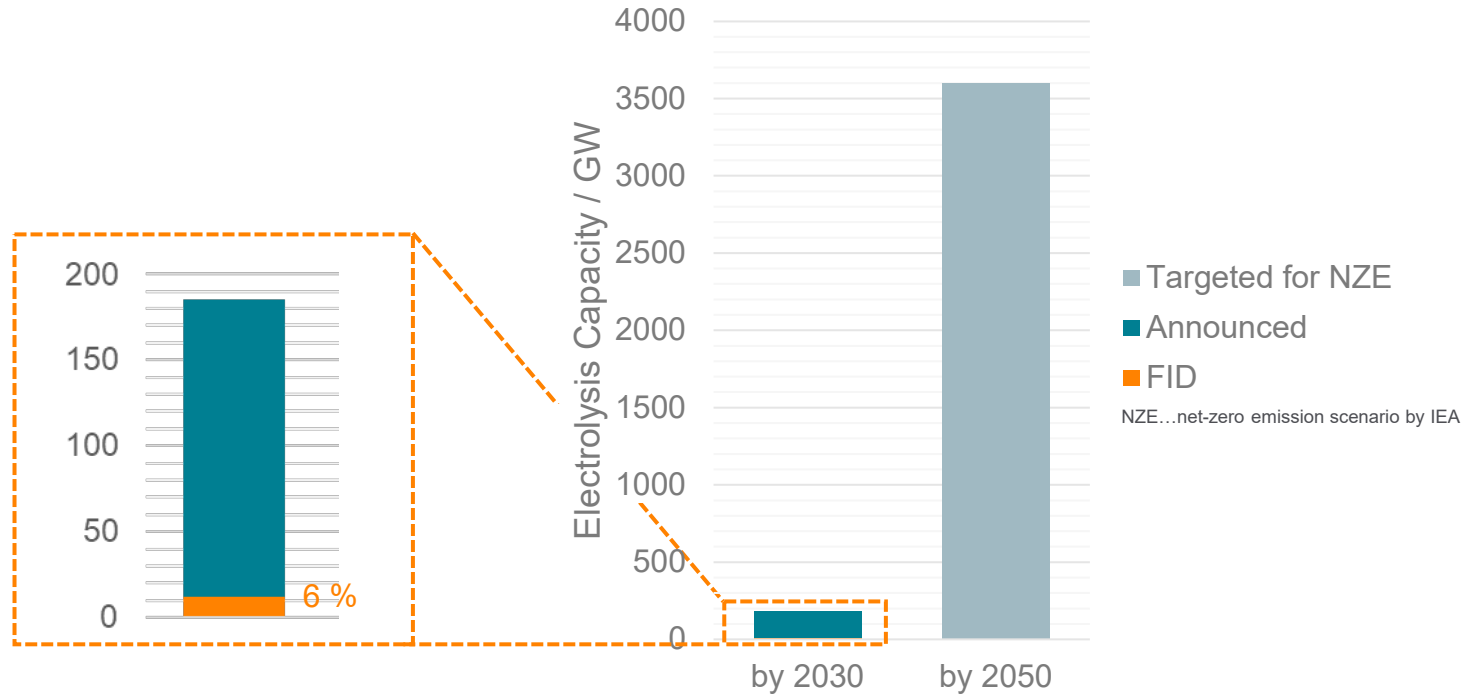
“

We are not bankable!

- ✗ Lack of long-term experience data on technology performance
- ✗ Lack of offtake agreements
- ✗ Lack of standards / certificates
- ➔ Scale-up risks



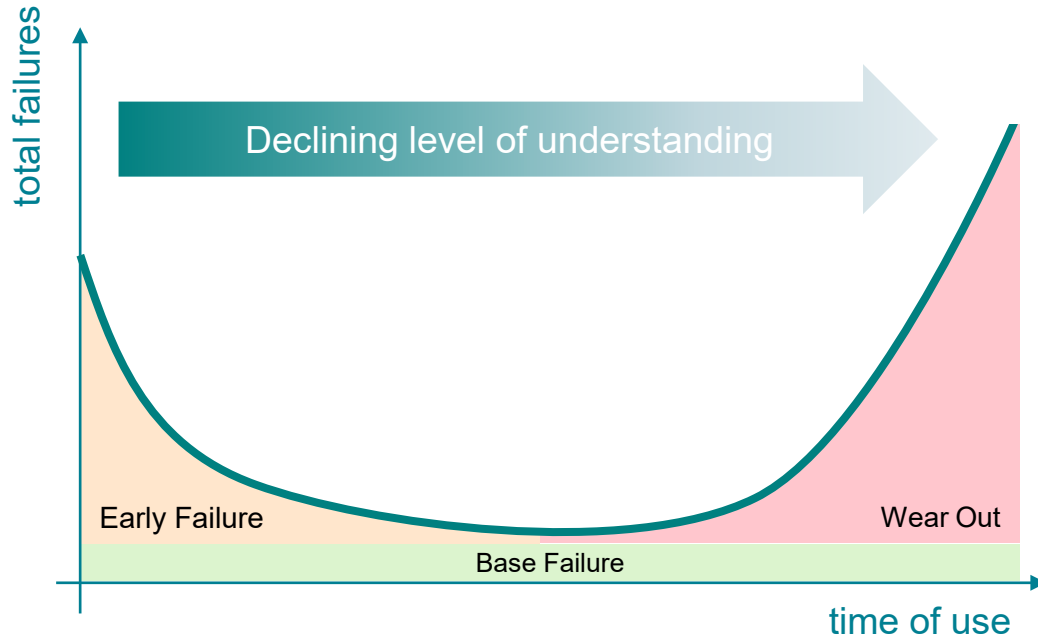
Green Hydrogen Scale in a Net Zero Emission Scenario



Data Source: [IEA, Global Hydrogen Review, 2023], recalculated from a 2030 annual hydrogen production of 27Mt via electrolysis assuming 7000h/a and average operating hours and 48kWh/kg, early stage announcements included; updated with End of 2023 FIDs published by [Hydrogen Council, Hydrogen project Pipeline. Dec 12, 2023]

Business Case: “To Have and Have Not” (1/2)

Spotlight on Component Failure



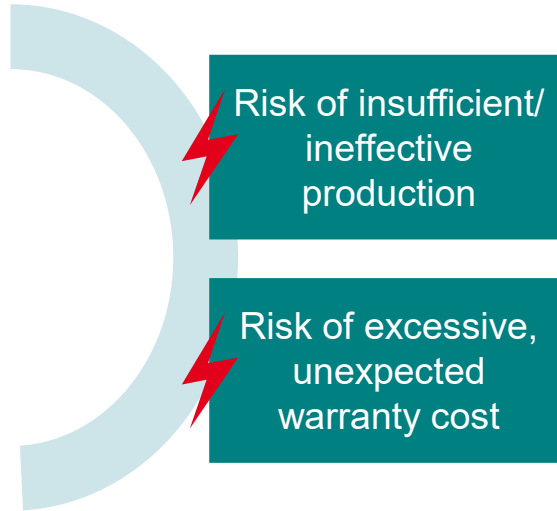
Limited information from preliminary material and component testing

- × Uncertain component failure rates
- × Unknown wear-out times
- × Undetermined serial loss probability

Business Case: “To Have and Have Not” (2/2)

Spotlight on Performance and Durability Risks

- Limited technological maturity
 - considerable uncertainties in scaling, performance and durability aspects
- Complex, non-linear aging behavior
 - multi-component systems
 - interrelated and often mutually reinforcing degradation mechanisms

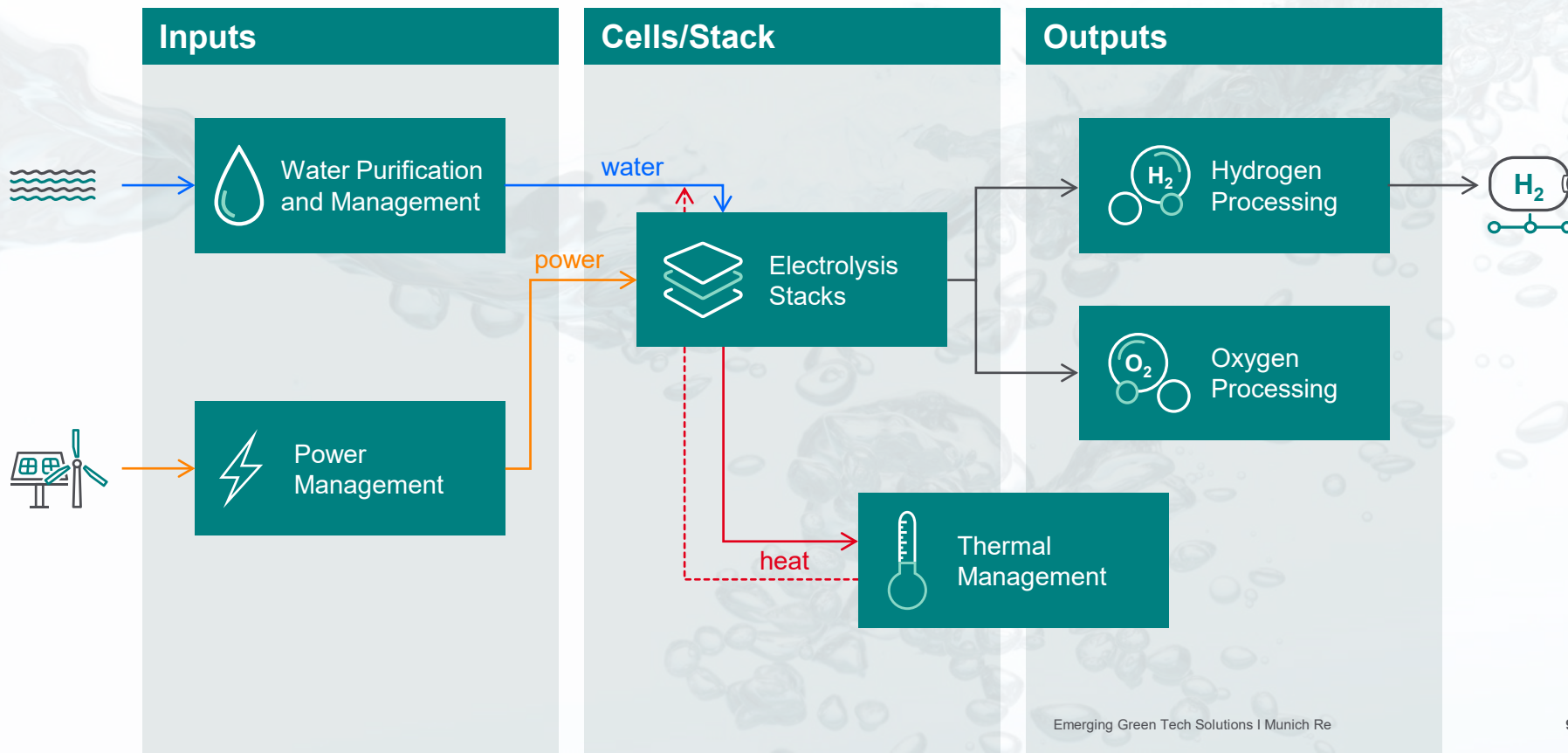


- × Business case is built on performance and durability assumptions
- × Accelerated degradation, progressing wear-out, serial losses etc. not accounted for
- × Reserves only consider “the expected”

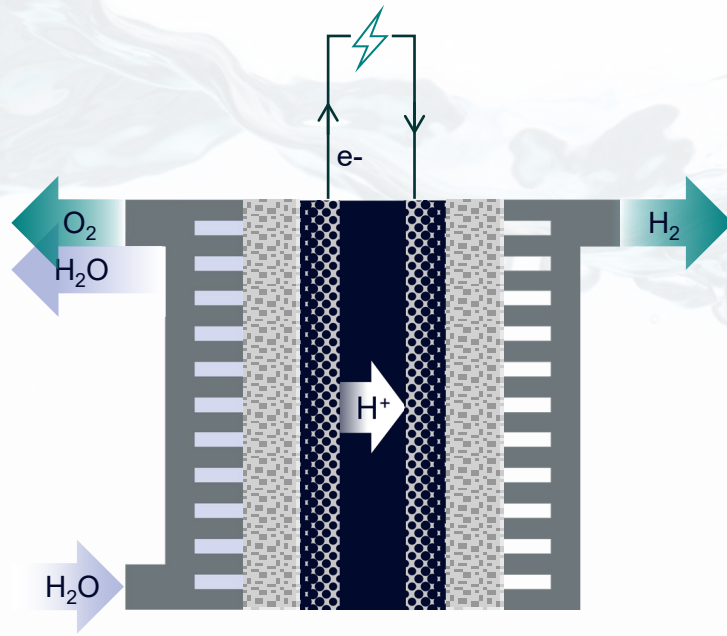
 **impairs bankability of hydrogen projects**

Simplified flow chart of an electrolysis plant

(only major streams from/to the electrolysis stacks are shown; the grey boxes indicate the system boundaries as considered herein)



PEMWE



■ Bipolar Plates

- electrical connection
- water distribution and product gas removal
- host coolant channels
- mechanical support

■ Porous Transport Layers

- gas and water transfer
- electrical connection
- heat transfer
- mechanical support

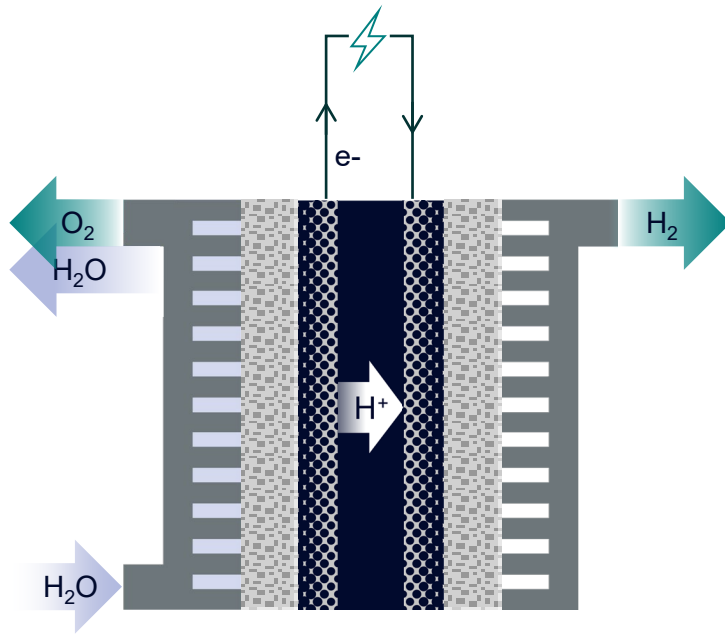
■ (Catalyst coated-) Electrodes

- host reaction sites
- transfer electrons, ions and gases to/from the reaction site

■ Membrane (electrolyte)

- transfers protons H^+
- electrical insulation
- prevents gas mixing

PEMWE

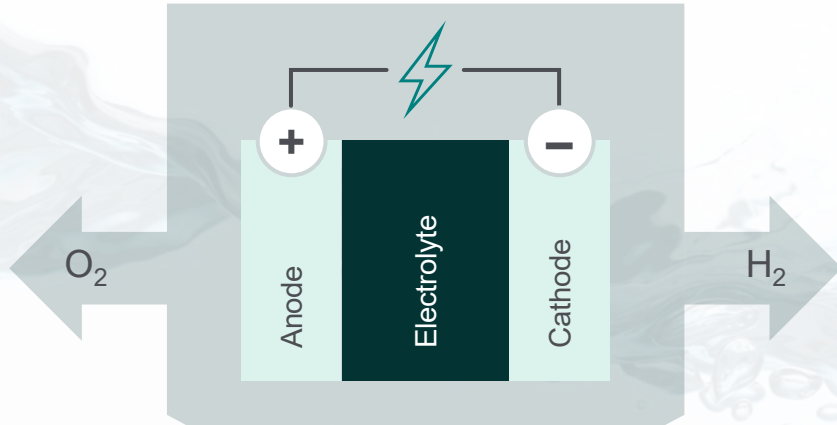


- **Bipolar Plates**
 - electrical connection
 - water distribution and product gas collection
 - host coolant channels
 - mechanical support
- **Porous Transport Layers**
 - gas and water transfer
 - electrical connection
 - heat transfer
 - mechanical support
- **(Catalyst coated-) Electrodes**
 - host reaction sites
 - transfer electrons, ions and gases to/from the reaction site
- **Membrane (electrolyte)**
 - transfers protons H⁺
 - electrical insulation
 - prevents gas mixing

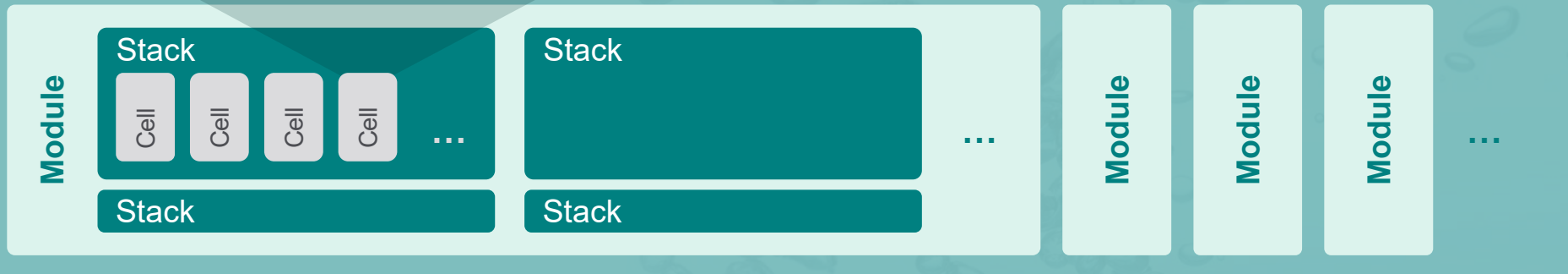
Stressors & Impact Factors:

- Ambient conditions
- Use Case
- Load management
- Feed Purity
- Materials
- Component Manufacturing and Assembly
- Etc.

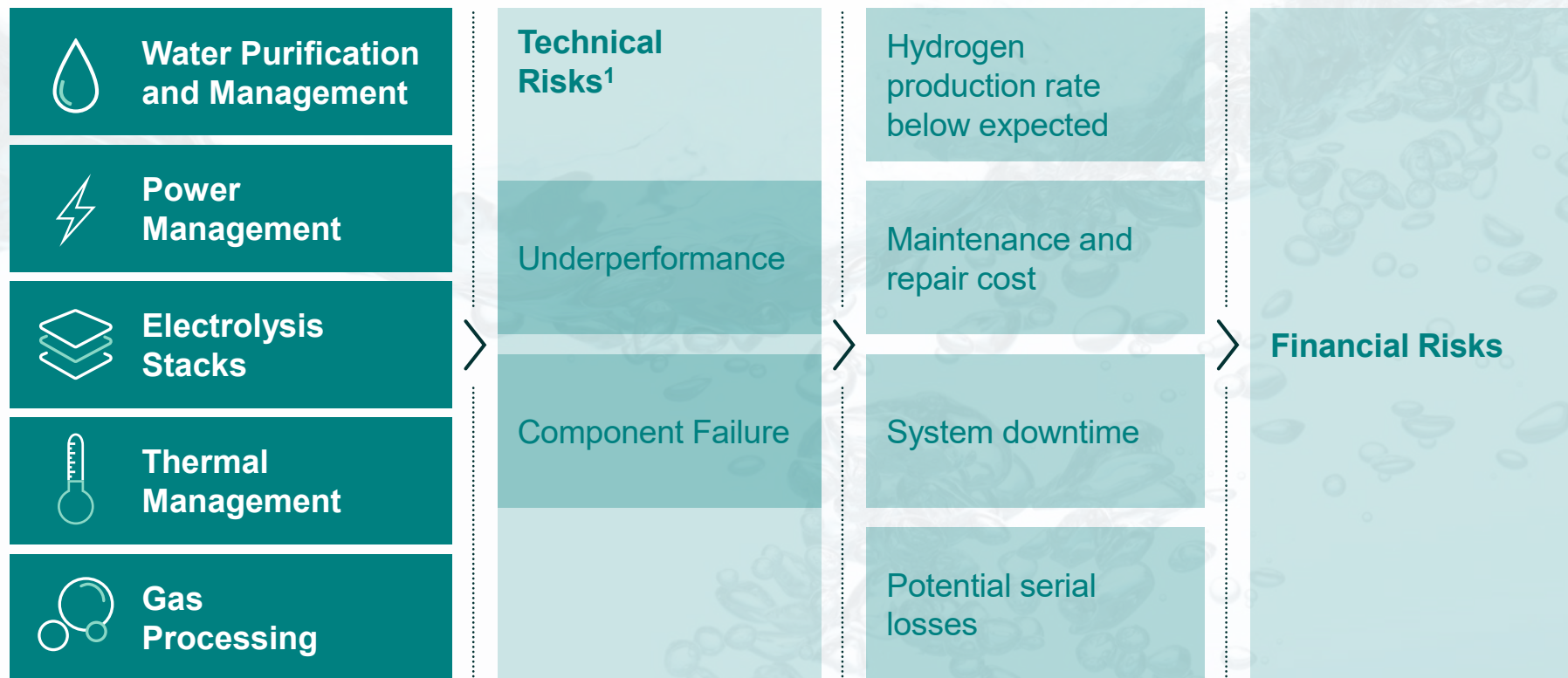
Schematic illustration of cell-, stack- and module-level of an electrolyzer



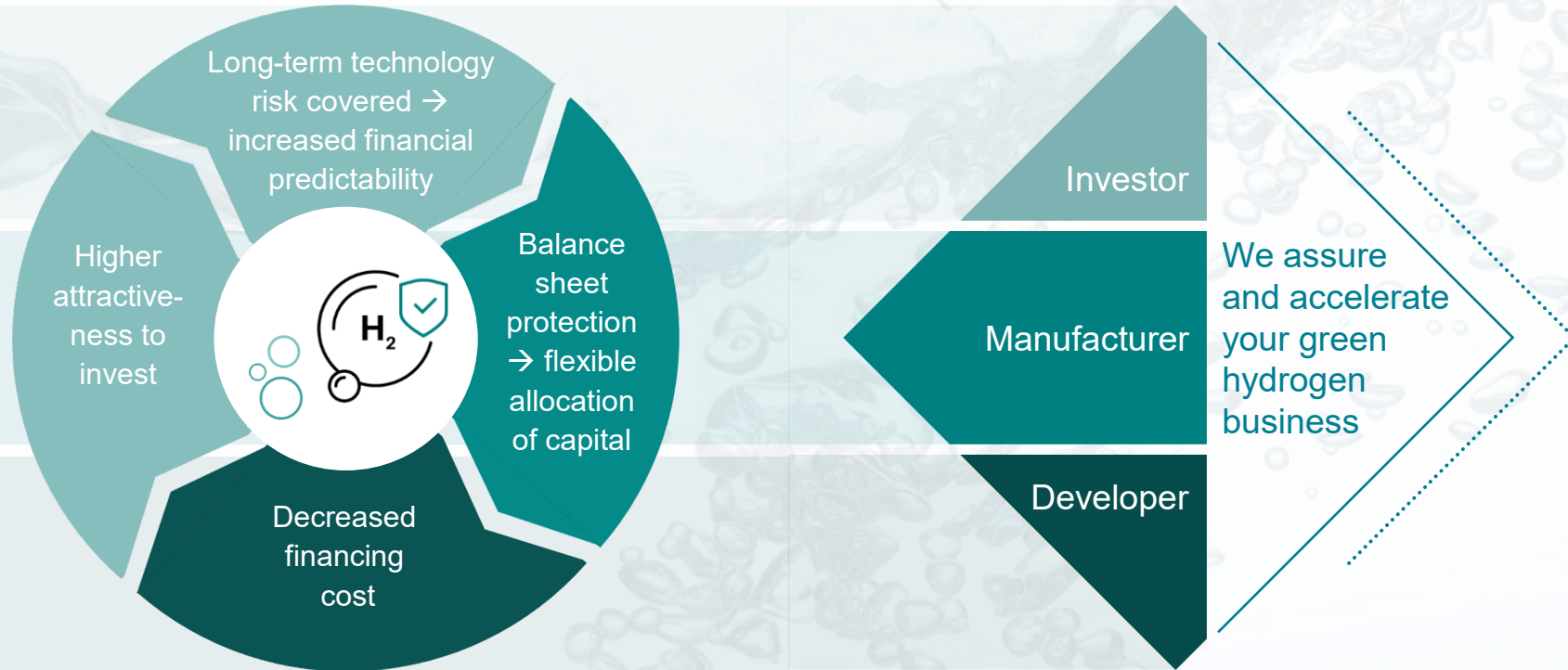
- multi-component systems
- interrelated and often mutually reinforcing degradation mechanisms
- influenced by multiple factors (ambient conditions, use case, materials, feed purity etc.)



Summary of technical risks in an electrolyzer plant and their impact



HySure™ Warranty Backstop: An Innovative Risk Transfer Solution to Grow Your Business and Drive Success



Key Take Aways

- Green hydrogen is expected to play a **key role** in the energy transition **as a renewable energy vector**
- **Current deployment** of green hydrogen **production capacities are very limited**
→ reaching deployment targets **requires rapid scaling**
- Currently, **hesitation** to invest capital **observed**
- **Technology-related risks** and uncertainties represent a critical aspect
- **Risk transfer solutions** such as HySure™ can **aid mitigating** these risks



Stay in touch!

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