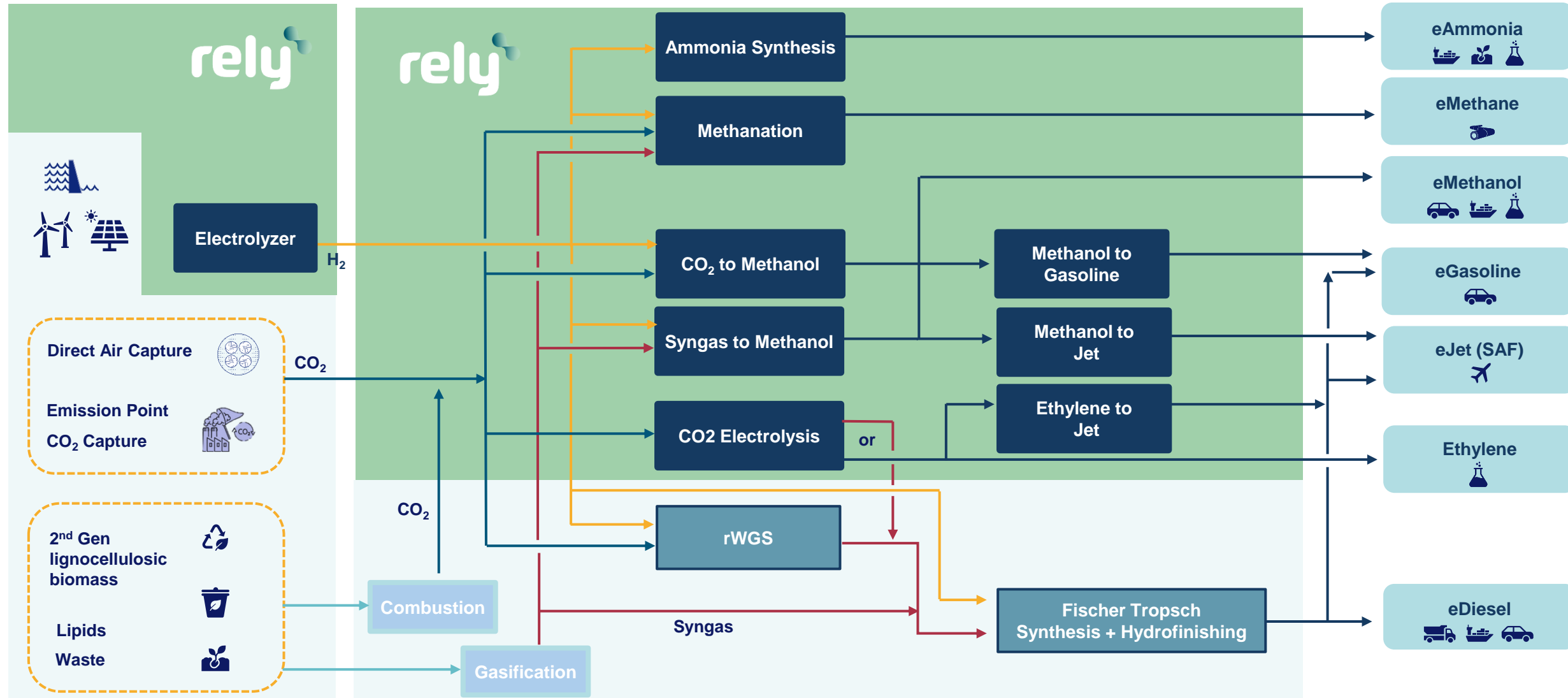


# Unlocking GH2 & PtX Market: A Holistic Approach to Safety and Sustainability

**Carolina Nugroho**

Deputy Chief Technology Officer

# Main Hydrogen Uses – Simplified view



# Hydrogen & Derivatives Challenges



**We accept  
challenges**



**We remain  
grounded**



**We are  
empowered**

**We promote  
partnerships**

# Safety: Hydrogen Risks



Leveraging on mother companies expertise

- › >30% Global Hydrogen Plants safely commissioned, started-up, delivered
- › +1,300 references stacks worldwide with 80+ stacks delivered
- › Safety Feedbacks from Industrial Scale Green H2 operating facility



Hydrogen



Gastech

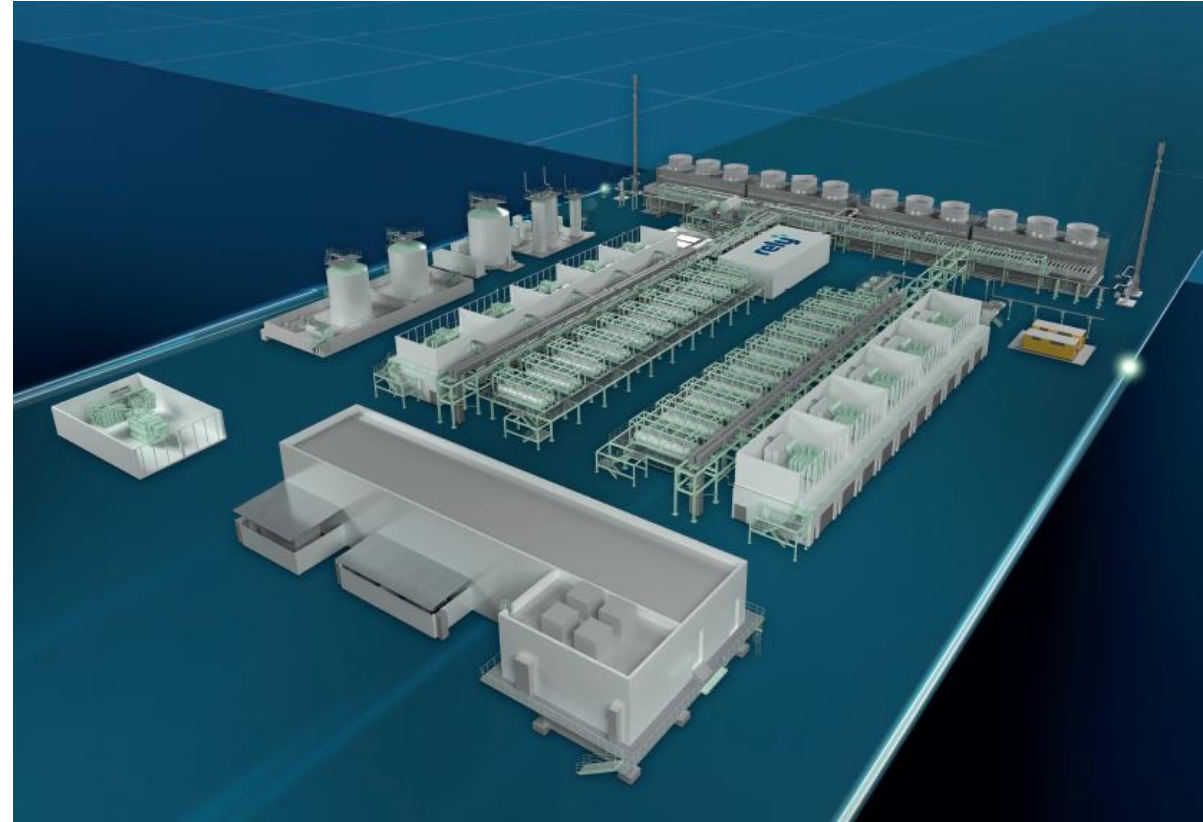


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rely<sup>+</sup>

# Safety: Main Risks in a Large-scale GH2 Facility

<b>Electrolyser Stack</b>	<ul style="list-style-type: none"><li>▪ Formation of H2/O2 mixture inside the stacks</li><li>▪ Pressurized Leakage (KOH + H2) or (KOH + O2)</li><li>▪ Electrical Risk</li></ul>
<b>Separators</b>	<ul style="list-style-type: none"><li>▪ Formation of H2/O2 mixture inside separator</li><li>▪ Lye Leak</li><li>▪ Pressurized H2 leak</li><li>▪ Pressurized O2 leak</li></ul>
<b>PDU</b>	<ul style="list-style-type: none"><li>▪ Pressurized H2 leak</li></ul>
<b>Vents</b>	<ul style="list-style-type: none"><li>▪ H2 Release (when depressurizing)</li><li>▪ O2 Continuous Release</li></ul>
<b>Compressor (OSBL)</b>	<ul style="list-style-type: none"><li>▪ Pressurized H2 leak</li></ul>



Hydrogen



Gastech



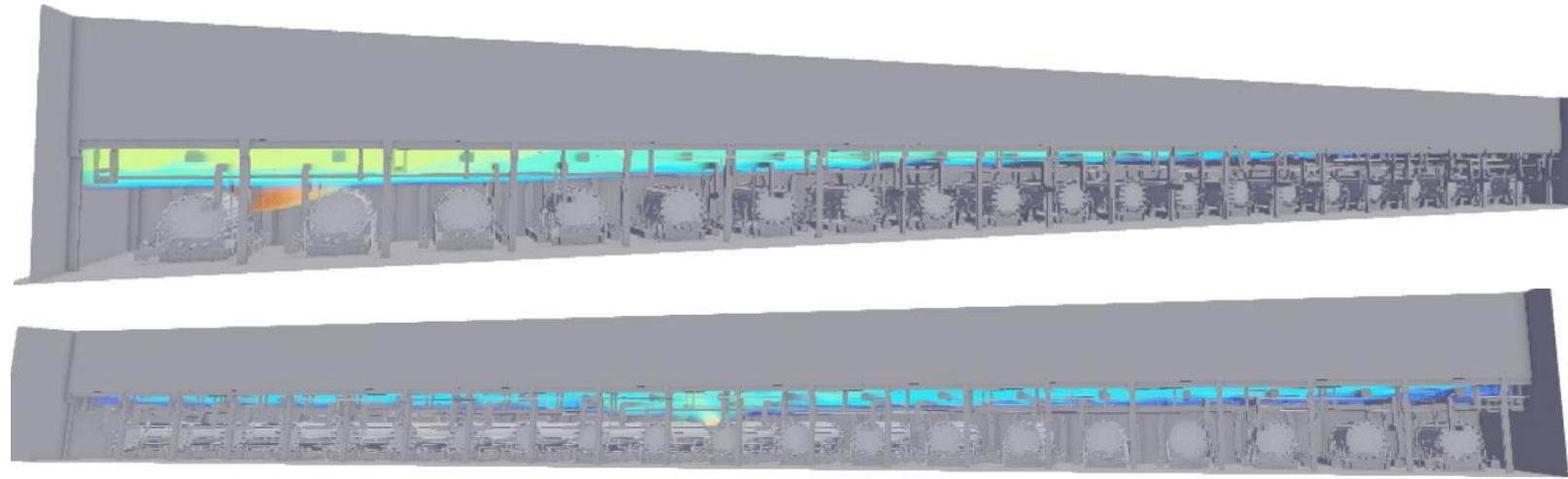
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# Safety-by-Design Features of Clear100+

**Safety and environmental reviews:**  
HAZID; ENVID; HAZOP; SIL/LOPA

**Safety Studies and Safety Design:**

- Consequence analysis
- Vent dispersion and radiation
- QRA including CFD dispersion and Explosion modelling
- Hazardous Area Classification
- Safety concept



- Choice of Electrolysis technology
- 62% Building Space saved by Balance of Stack outside building
- Plot Layout – contours – no hazardous consequence outside fence, no escalation



Hydrogen

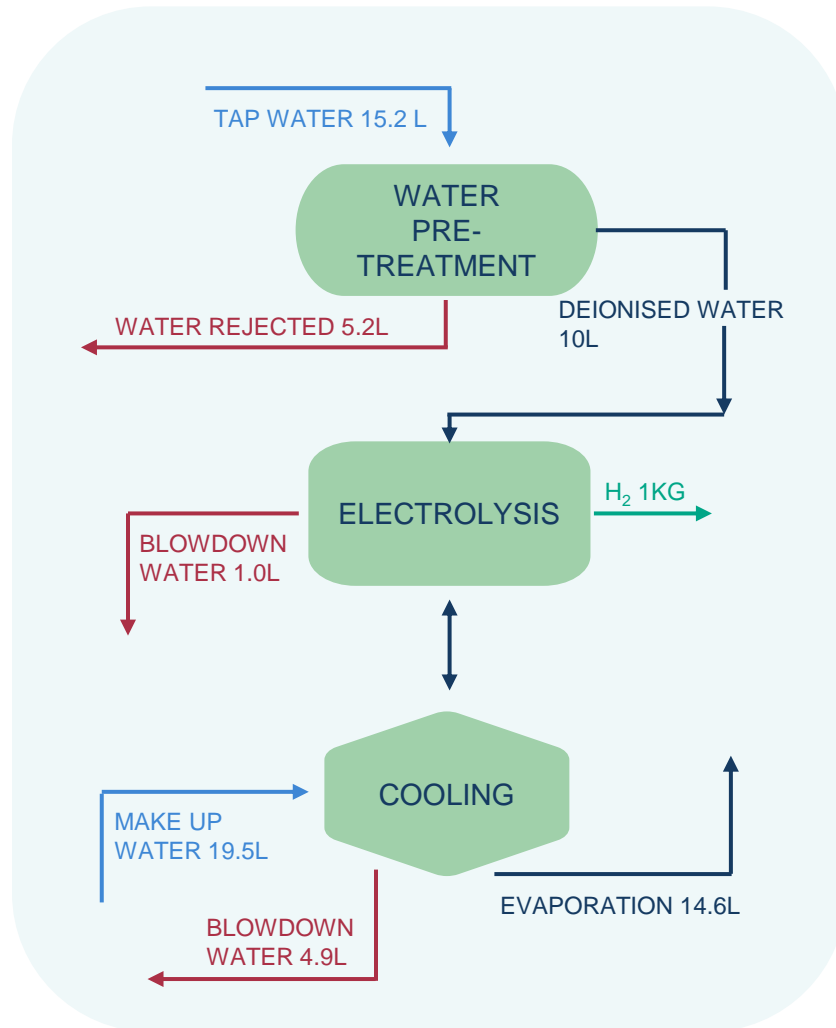


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# Environmental Sustainability: Water Scarcity



**SCHEMATICS OF PROCESS-SPECIFIC  
WATER WITHDRAWAL AND CONSUMPTION  
FOR TYPICAL HYDROGEN TECHNOLOGIES  
TO GENERATE 1 KILOGRAMME OF HYDROGEN**

*Source: IRENA and BlueRisk (2023), Water for hydrogen production, International Renewable Energy Agency, BlueRisk, Abu Dhabi, United Arab Emirates.*



Hydrogen



Gastech



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# Environmental Sustainability: Water Scarcity

**REDUCE**  
**REUSE**   
**RECYCLE**

- Air Cooler => less 80% water use
- Choice of AWE technology, with no rare metals
- Choice of material resistant to corrosions
- Mutualization, reducing material use
- Lye management, filtration and reuse



Hydrogen



Gastech



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# Environmental Sustainability: GHG Emissions



- 10 tons H<sub>2</sub> per annum saved by Insulation on stand-by / intermittent conditions
- H<sub>2</sub> flaring (thermal oxidation of H<sub>2</sub>O) for emergency / accidental scenarios
- Minimization of flanges



Hydrogen



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# Integrating Future Innovations into the Next Generations

Electrolysis

Materials

Balance of Plant mutualization

Process integration

Dynamic Responses

Plant Automation

# Let's take this further!



Carolina Nugroho  
Deputy CTO



[carolina.nugroho@relysolutions.com](mailto:carolina.nugroho@relysolutions.com)

Find out more:

<https://www.relysolutions.com/>



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