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# Water Resources and Hydrogen Atlas: Potential for Green Hydrogen Development in Kazakhstan

*Strengthening Regional Cooperation for  
Green Hydrogen: Infrastructure Pathways and  
Opportunities*

*Paul Bertheau*

*Reiner Lemoine Institut*



# The Reiner Lemoine Institut (RLI)

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## Overview

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- Not-for-profit research institute
- 100% owned by Reiner Lemoine Stiftung (RLS)
- Based in Berlin, established in 2010
- Managing director: Dr. Kathrin Goldammer
- >100 researchers + students



**Reiner Lemoine**  
Founder of the Reiner Lemoine  
Foundation

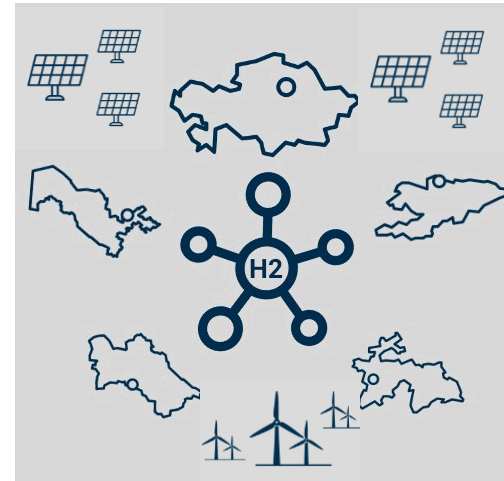
## Mission

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Scientific research for an energy transition  
towards **100 % Renewable Energy**

# Brief project info - GreenHyReCa

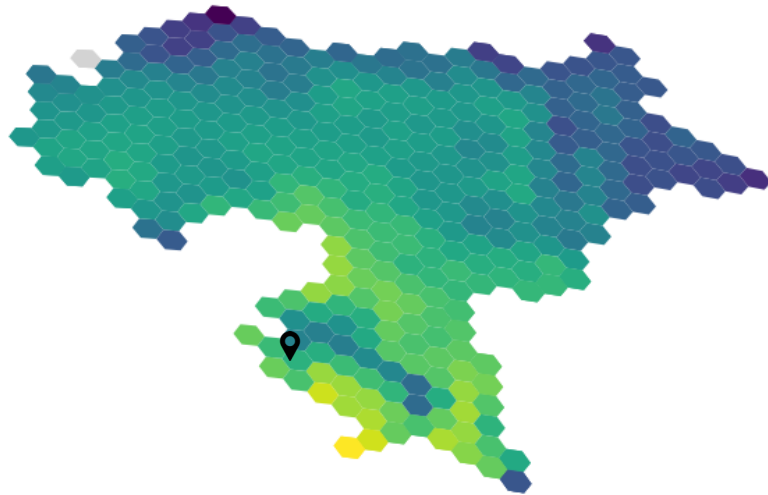
- **Key objective:** Establish Central Asian-German research network focusing on Green Hydrogen
- **Main research topic:** Open source-based modelling of complex energy systems
- **Project duration:** January 2023 – September 2025
- **Project funding:** Funded by BMBF through “Zuwendungen für internationale Projekte zum Thema Grüner Wasserstoff“



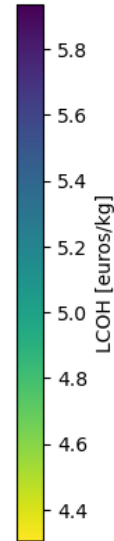
<https://reiner-lemoine-institut.de/en/project-hyreca/>

# Open Source Modelling of Green Hydrogen Production

## Geospatial cost optimization of green hydrogen production



Kazakhstan MAN-ATY-ZAP-AKT LCOH Map



### Driving question:

What would be the resulting LCOH of building a green H<sub>2</sub> plant at any hexagon to transport\* X amount of H<sub>2</sub> (in X demand state)\*\* to X location for export?

\*Either by trucks or by pipeline

\*\*Either compressed H<sub>2</sub>, liquid H<sub>2</sub> or ammonia

# Motivation & Disclaimer

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Goal: Creating LCOH maps for central asian regions (green HyRECA)

- ▶ The tools shown are not developed by RLI, only applied to our case study
- ▶ Based on LCOH case study in Namibia
- ▶ Specifically, the main tool is called GeoH2 and uses a few other tools as support
- ▶ GeoH2/GeoH2-data-prep: <https://github.com/ClimateCompatibleGrowth/GeoH2> and <https://github.com/ClimateCompatibleGrowth/GeoH2-data-prep>
- ▶ GLAES: <https://github.com/FZJ-IEK3-VSA/glaes>
- ▶ Spider: <https://github.com/carderne/ccg-spider>

Repo: <https://github.com/ClimateCompatibleGrowth/GeoH2>

# How do we get there? – Geospatial steps 1-3

## How do we get there? - Step 1: GLAES

Goal: Estimate available land for PV/Wind turbines

- Inputs:
  - CORINE Land cover dataset
  - RE asset parameters (e.g. size, separation)
- Exclusion criteria:
  - Distance from coasts and water bodies
  - Wetland, cropland
  - Settlements
  - ...
- Output: Eligible turbine/PV placements

Repo: <https://github.com/FZJ-IEK3-VSA/glaes>

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## How do we get there? - Step 2: Spider

Goal: Create hexagon data file with desired features

- Inputs:
  - Area boundaries
  - Source files for relevant features (e.g. roads to compute road\_dist)
- Output: Hexagon file with defined features



Repo: <https://github.com/carlleme/cog-spider>

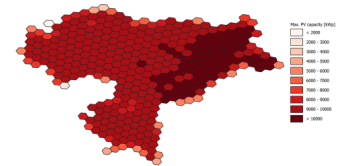
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## How do we get there? - Step 3: join

Goal: Add available land for PV and wind (theoretical max. capacities) to hexagon file

- Inputs:
  - GLAES output: Available turbine and PV placement
  - Spider output: Hexagon file with relevant features
- Output: Hexagon file including theo\_pv and theo\_wind



Repo: <https://github.com/ClimateCompat&eGrowth/Geoz2-data-prep>

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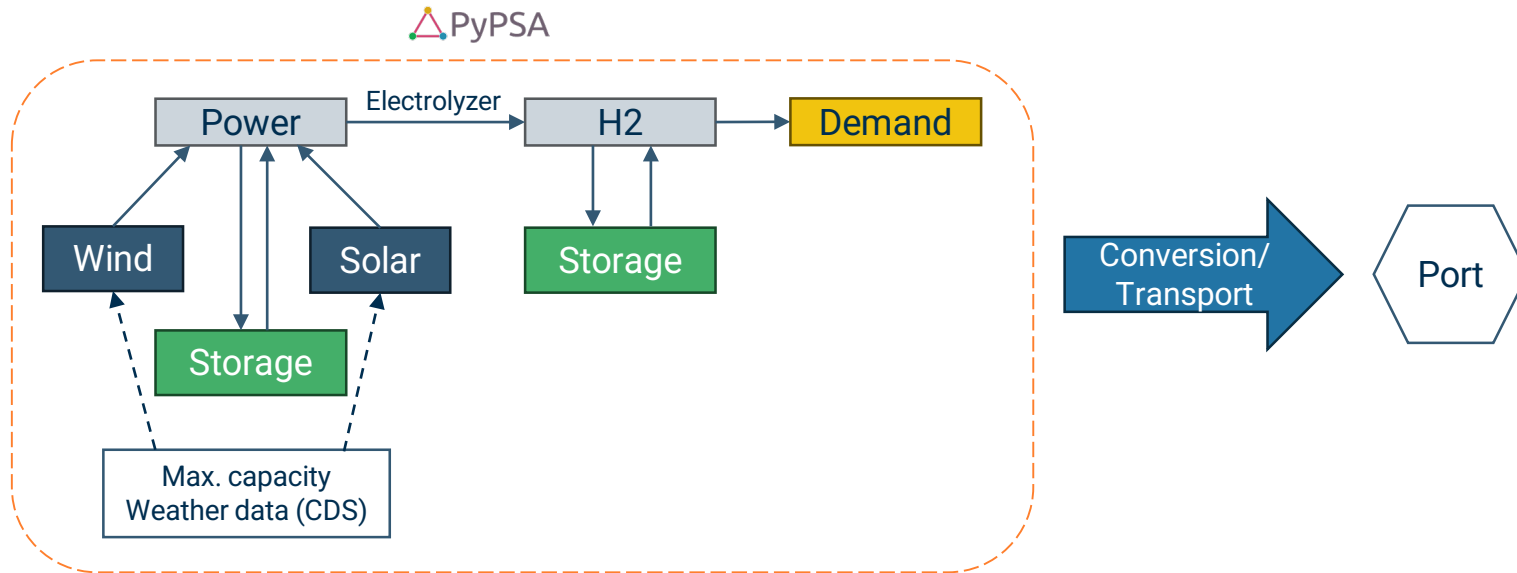
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# How do we get there? Step 4: GeoH2 - Optimization

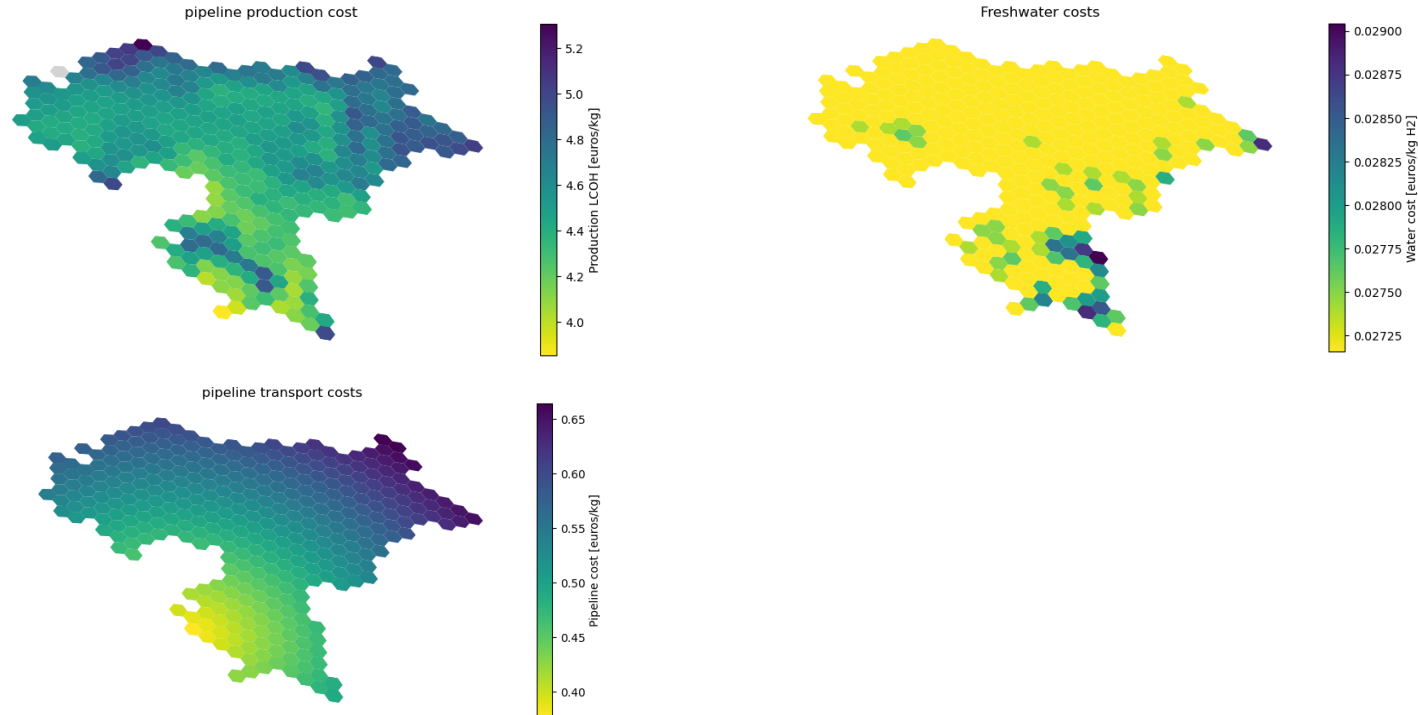
Goal: Find out necessary capacities for each hexagon to fulfill demand

▶  $LCOH = C_{production} + C_{water} + C_{conversion} + C_{transport}$



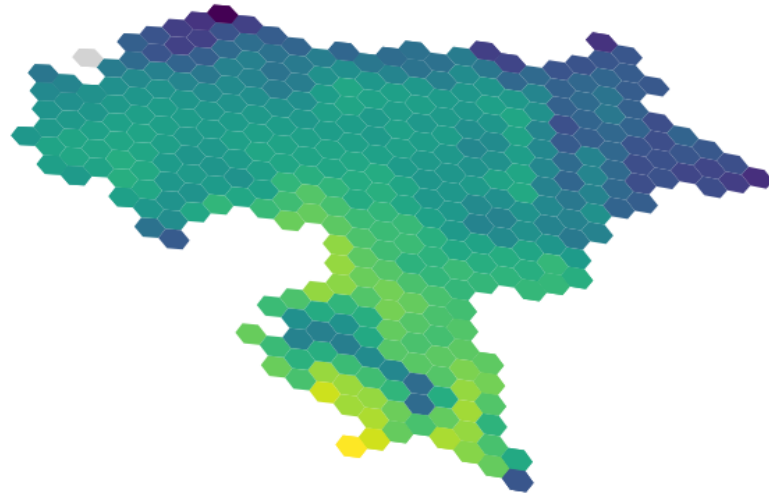
# How do we get there? Step 4: GeoH2 - Optimization

Goal: Find out necessary capacities for each hexagon to fulfill demand

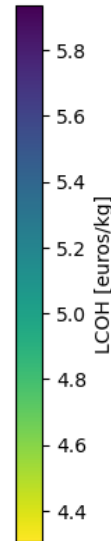


# GeoH2 Tool output for Western Kazakhstan

## Geospatial cost optimization of green hydrogen production



Kazakhstan MAN-ATY-ZAP-AKT LCOH Map



### Driving question:

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# Guest research visit for water sector analysis

Three questions for: Kazakh guest researchers at the RLI



March 19, 2024 | Four weeks of exchange, four weeks of joint work: three guest researchers from Kazakhstan are visiting the RLI in March. Aigerim Karibay (KMG Engineering), Gulzhiyan Kabdulova and Ayazhan Karabayeva (national company Kazakhstan Gharysh Sapary) are working together with the RLI researchers as part of the "Green HyRECA" project. They are working on the question of how much water is available for the production of hydrogen in Central Asia. Based on a test area in western Kazakhstan, the scientists want to develop a method that can also answer this question for the whole of Central Asia. The exchange is being organised in cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit and the "EcoAral" project.

- Visit of Kazakh researchers from KMG-E and QAZSPACE (early 2024)
- Focus: Collect and analyze data for water sector in Western KZH (MAN-ATY-ZAP-AKT)
- Result: Some data available but much more open access data required!
- Researcher mobility supported by GIZ H2Diplo & GIZ EcoAral
- Data and feedback by DLR
- Big thanks for the support!

# Showcase of prototype webmap

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Link to webmap draft

# Future collaboration and customization...

## Editable inputs

- ▶ **GLAES**
  - ▶ Additional land cover/exclusion criteria inputs, depending on data availability
  - ▶ E.g. OSM road data could be used to set a buffer around roads
  - ▶ Different assumptions for RE asset sizes and separation
- ▶ **Spider**
  - ▶ Additional features, depending on data availability (currently distance to roads and waterbodies/waterways)
  - ▶ Different hexagon resolution
- ▶ **Parameters:**
  - ▶ Energy system model parameters (asset CAPEX, lifetime, etc.)
  - ▶ H2 Conversion parameters (demand for export can be either NH3, LH2 or 500 bar)
  - ▶ Transport parameters
    - ▶ Trucking parameters (road CAPEX, OPEX, capacity, speed, wages...)
    - ▶ Pipeline parameters (CAPEX, OPEX, capacity...)
  - ▶ Water parameters (transport costs, treatment costs, demand for H2...)
  - ▶ Electricity and heat prices

Source: <https://github.com/FZJ-IEK3-VSA/glaes>

# Thanks!



**Your ideas?**

- ... Partnerships
- ... Research cooperations
- ... Joint project proposals



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