Project: GreenHyReCa
Green Hydrogen Generation Potential based on **R**enewable **E**nergies in **C**entral **A**sia

InnoWeek 2023 - UN-ECE Session:

“Ways for Sustainable Hydrogen Production in Uzbekistan”

Reiner Lemoine Institut

Dr. Paul Bertheau

The Reiner Lemoine Institut (RLI)

Overview

- 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

Alliance for Rural Electrification

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

Reiner Lemoine
Founder of the Reiner Lemoine Foundation

Mission

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

Agenda

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- The German Energy Transition and Green Hydrogen
- Central Asia: Role in Green Hydrogen Production
- GreenHyRECA project: Goals and Activities
- On a short glance: Uzbekistan case study
- Conclusion

Germany: Projection of future hydrogen demand

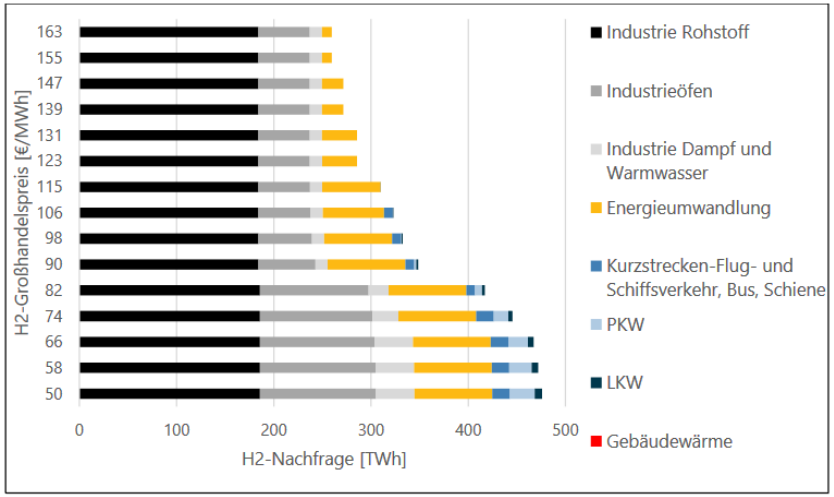


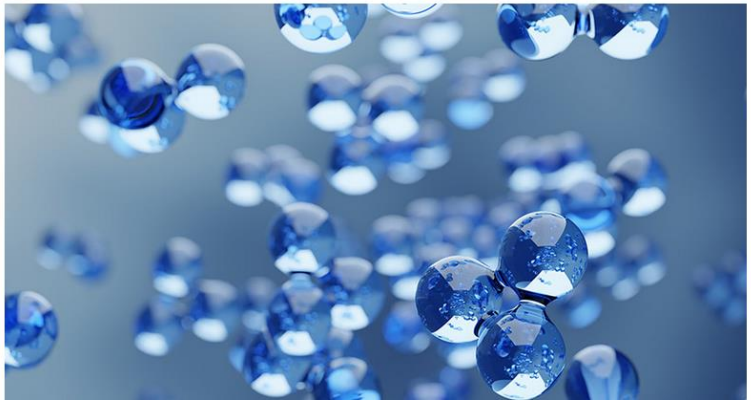
Figure: Price-dependent hydrogen demand in Germany projected for Greenhouse gas neutrality in 2045
Source: HYPAT Working Paper 01/2023: Preiselastische Wasserstoffnachfrage in Deutschland – Methodik und Ergebnisse
Link: https://www.hypat.de/hypat-wAssets/docs/new/publikationen/HyPAT_Working-Paper-01_2023_Preiselastische-Nachfrage.pdf

- Climate-neutrality by 2045
- Today: Renewable share almost 50% of electricity production
- However, slower progress in the transport, heating, industrial sector
- Green H2 is required for full scale decarbonization of all energy intensive sectors
- Depending on the H2 costs Germany's demand ranges between 250 – 480 TWh/a

Germany: National Hydrogen Strategy

The National Hydrogen Strategy

Germany has set itself ambitious energy and climate targets. By 2045, Germany wants to achieve greenhouse gas neutrality. To achieve these goals, there is need to significantly increase energy efficiency. Germany also needs to decarbonise its energy and raw material supply, which is still largely based on fossil fuels, by switching to renewable or renewable-based energy sources, such as hydrogen. The Federal Government has therefore developed a National Hydrogen Strategy to drive forward the use of climate-friendly hydrogen technologies. On this page, you can learn more about the goals of this strategy, how it is being implemented, and what funding opportunities are available.



Link: https://www.bmwk.de/Redaktion/EN/Hydrogen/Dossiers/national-hydrogen-strategy.html

- National Hydrogen Strategy consists of eight action area including: **International hydrogen market and external economic partnerships**
- *"The domestic hydrogen market will be far from sufficient to provide the quantities of hydrogen needed to de-carbonize at the level desired"*
- *"Germany will have to cover a large proportion of its hydrogen demand via imports"*

Central Asia: Role in Green Hydrogen Production

Green Hydrogen Potential:

- Excellent renewable resources (solar, wind)
- Potential availability of land to develop RE and H2
- Existing power grid and pipeline infrastructure
- Green H2 as a new export good ???

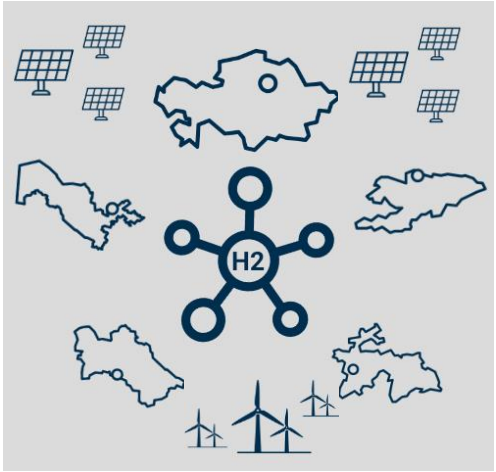
Challenges ahead:

- Climate change impacts
- Increasing energy/ electricity demand
- Depletion of fossil resources
- Water scarcity/resource conflicts
- Export of resources

Brief project info - GreenHyReCa

- **Key objective:** Establish Central Asian-German research network focusing on Green Hydrogen
- **Main research topic & activities:**
  - Open source based modelling of complex energy systems
  - Energy transition pathways for Central Asian Countries considering hydrogen
  - Capacity training through workshops
- **Project duration:** January 2023 – December 2024

- **Project funding:** Funded by BMBF through “Zuwendungen für internationale Projekte zum Thema Grüner Wasserstoff“



Specific ongoing activities

- **Open-source based modelling of energy transition pathways – case study for Uzbekistan**
- Development of geospatial atlas for water availability – case study for Western Kazakhstan

Open-source based modelling of energy transition pathways – Methodology

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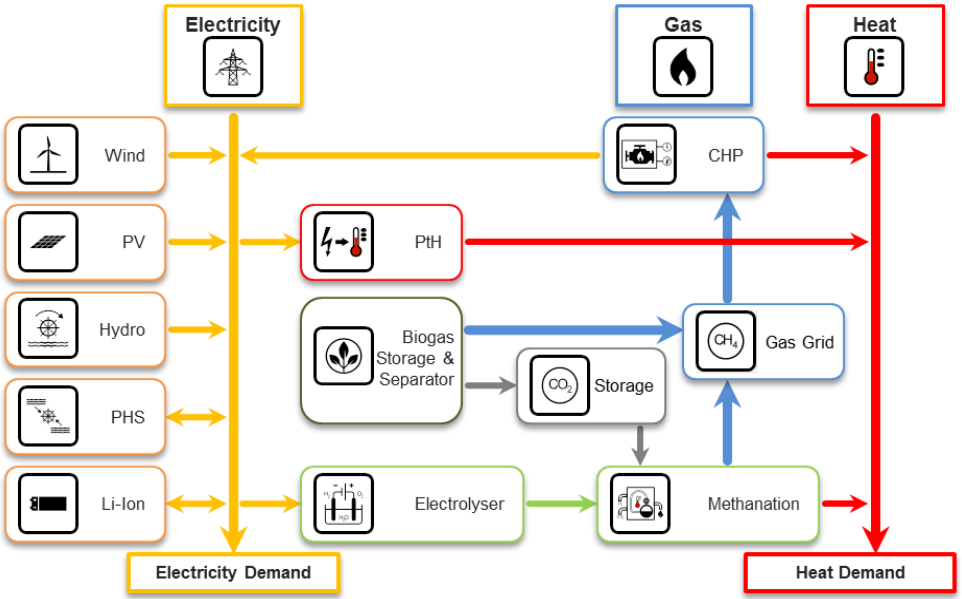
open energy modeling framework

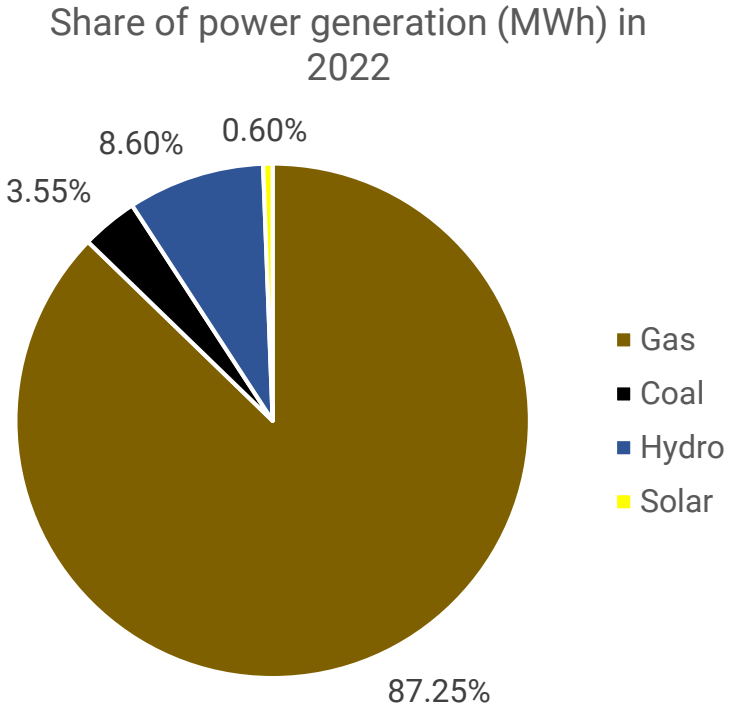
Our toolbox for energy system analysis

- Sector-coupled energy systems
- Feed-in time series wind/PV/hydro
- Power and heat demand profiles
- Simulation of thermal processes
- Optimization regarding emissions, costs, specific technology shares etc.



Open-source based modelling of energy transition pathways – case study for Uzbekistan

- Electricity system heavily based on fossil fuels (2022)
- Electricity demand will rise
  - Status quo: 55 TWh
  - 2030: 106.9 TWh
- Natural gas reserves are likely to deplete in the next 20-30 years
- RE share: 10.5%
- LCOE: 0.085 USD/kWh



Open-source based modelling of energy transition pathways – case study for Uzbekistan

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Scenarios:

1. RE Policy Target
   - 7 GW PV, 5 GW Wind
2. Cost-Optimization
   - Least-cost
3. RE share of 80%
   - Least cost and RE share
4. H2 Export
   - Least-cost with H2 export

General constraints:

- Hourly simulation of demand and power generation
- 2030 electricity demand, secure supply
- Existing power capacity remains operational
- Power technologies: solar, wind, gas, coal
- Storage technologies: hydrogen, battery storage

Open-source based modelling of energy transition pathways – case study for Uzbekistan

	RE Policy Target	Cost-Optimization	RE share of 80%	H2 Export
Additional fossil capacity	N/A			
Additional RE capacity	+ 7.0 GW PV + 5.0 GW Wind			
Additional H2 capacity	+ 84 MW Elec. + 5.3 GW Fu. Ce. + 8.9 GWh H2 St.			
RE share (%)	21.73%			
LCOE (USD/kWh)	0.0750			
Emissions (kgCO2/kWh)	1.01			
Excess capacity (GWh)	367			

Open-source based modelling of energy transition pathways – case study for Uzbekistan

	RE Policy Target	Cost-Optimization	RE share of 80%	H2 Export
Additional fossil capacity	N/A	+ 5 GW Natural Gas		
Additional RE capacity	+ 7.0 GW PV + 5.0 GW Wind	+ 10.3 GW PV + 11.2 GW Wind		
Additional H2 capacity	+ 84 MW Elec. + 5.3 GW Fu. Ce. + 8.9 GWh H2 St.	.		
RE share (%)	21.73%	44.61%		
LCOE (USD/kWh)	0.0750	0.0679		
Emissions (kgCO2/kWh)	1.01	0.61		
Excess capacity (GWh)	367	8,339		

Open-source based modelling of energy transition pathways – case study for Uzbekistan

	RE Policy Target	Cost-Optimization	RE share of 80%	H2 Export
Additional fossil capacity	N/A	+ 5 GW Natural Gas		
Additional RE capacity	+ 7.0 GW PV + 5.0 GW Wind	+ 10.3 GW PV + 11.2 GW Wind	+ 18.0 GW PV + 19.8 GW Wind	
Additional H2 capacity	+ 84 MW Elec. + 5.3 GW Fu. Ce. + 8.9 GWh H2 St.	.	+ 2.5 GW Elec. + 4.5 GW Fu. Ce. + 12.5 GWh H2 St.	
RE share (%)	21.73%	44.61%	80.00%	
LCOE (USD/kWh)	0.0750	0.0679	0.0759	
Emissions (kgCO2/kWh)	1.01	0.61	0.21	
Excess capacity (GWh)	367	8,339	28,060	

Open-source based modelling of energy transition pathways – case study for Uzbekistan

	RE Policy Target	Cost-Optimization	RE share of 80%	H2 Export
Additional fossil capacity	N/A	+ 5 GW Natural Gas		+ 10 GW Natural Gas
Additional RE capacity	+ 7.0 GW PV + 5.0 GW Wind	+ 10.3 GW PV + 11.2 GW Wind	+ 18.0 GW PV + 19.8 GW Wind	+ 57.5 GW PV + 80.2 GW Wind
Additional H2 capacity	+ 84 MW Elec. + 5.3 GW Fu. Ce. + 8.9 GWh H2 St.	.	+ 2.5 GW Elec. + 4.5 GW Fu. Ce. + 12.5 GWh H2 St.	+ 42 GW Elec. . + 109 GWh H2 St.
RE share (%)	21.73%	44.61%	80.00%	72.18%
LCOE (USD/kWh)	0.0750	0.0679	0.0759	0.0843 (0.281)
Emissions (kgCO2/kWh)	1.01	0.61	0.21	0.28
Excess capacity (GWh)	367	8,339	28,060	39,069

Conclusion & Next steps

Conclusion

- Renewable energy can lead to lower costs, lower emissions and higher independence
- Excess electricity in scenario with high RE share can be utilized for H2 production
- Estimated H2 costs are in an attractive range of 88 USD/MWh

Next steps

- Development of multi-mode energy model for entire Central Asia
- Application for neighbouring countries and sector coupling
- In-depth sensitivity analyses
- Improvement and update of input data

Thank you very much for your attention!

Feel free to get in contact with us!

Your ideas?

… Partnerships
… Research cooperations
… Joint project proposals

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