

Designing and Evaluating Zero-Emission Refueling Infrastructure for Inland Waterway Transport (WP5)

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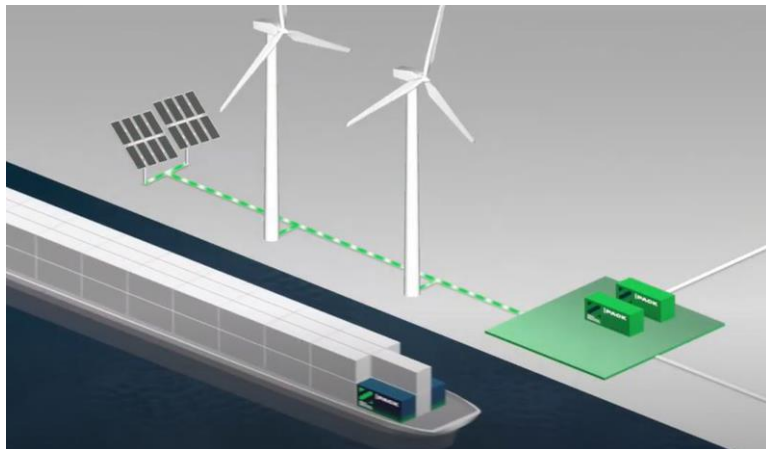
2nd April 2025

Start Date: 1st May 2023

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Research Objectives

Bunkering Station



Feedstock

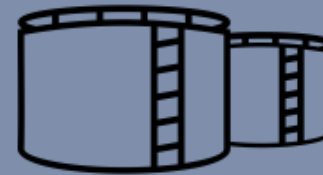
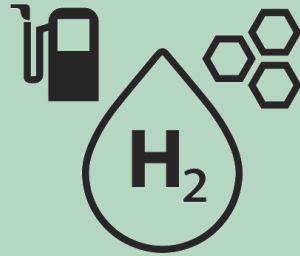
Production

Product

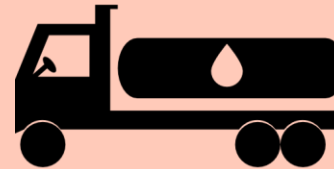
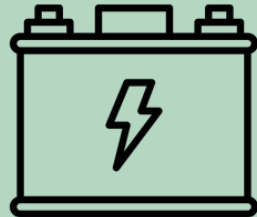
Distribution

Storage

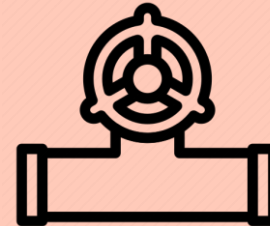
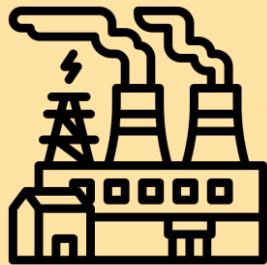
Bunkering



Swapping Station



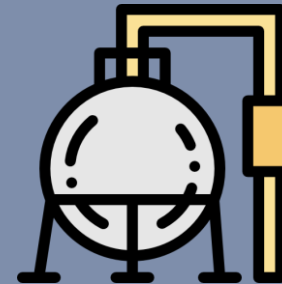
Truck-To-Ship



Ship-To-Ship



Pipeline



Station-To-Ship



- **Refueling Infrastructure Is Not Just About Location!**
- **Green Fuels Have Diverse and Complex Supply Chains!**
- **Fuel demand varies with waterway characteristics** (e.g., water depth, waterway width, presence of locks,..), **and vessel design** (e.g., vessel dimensions, engine power, sailing behaviour of vessels,...)
- **Mismatch between where refueling stations exist and where they are needed as fuel types and vessel types diversify!**
- **Infrastructure designs that look good on paper may fail under real-world uncertainty such as demand shifts, vessel behaviors changes,...!**

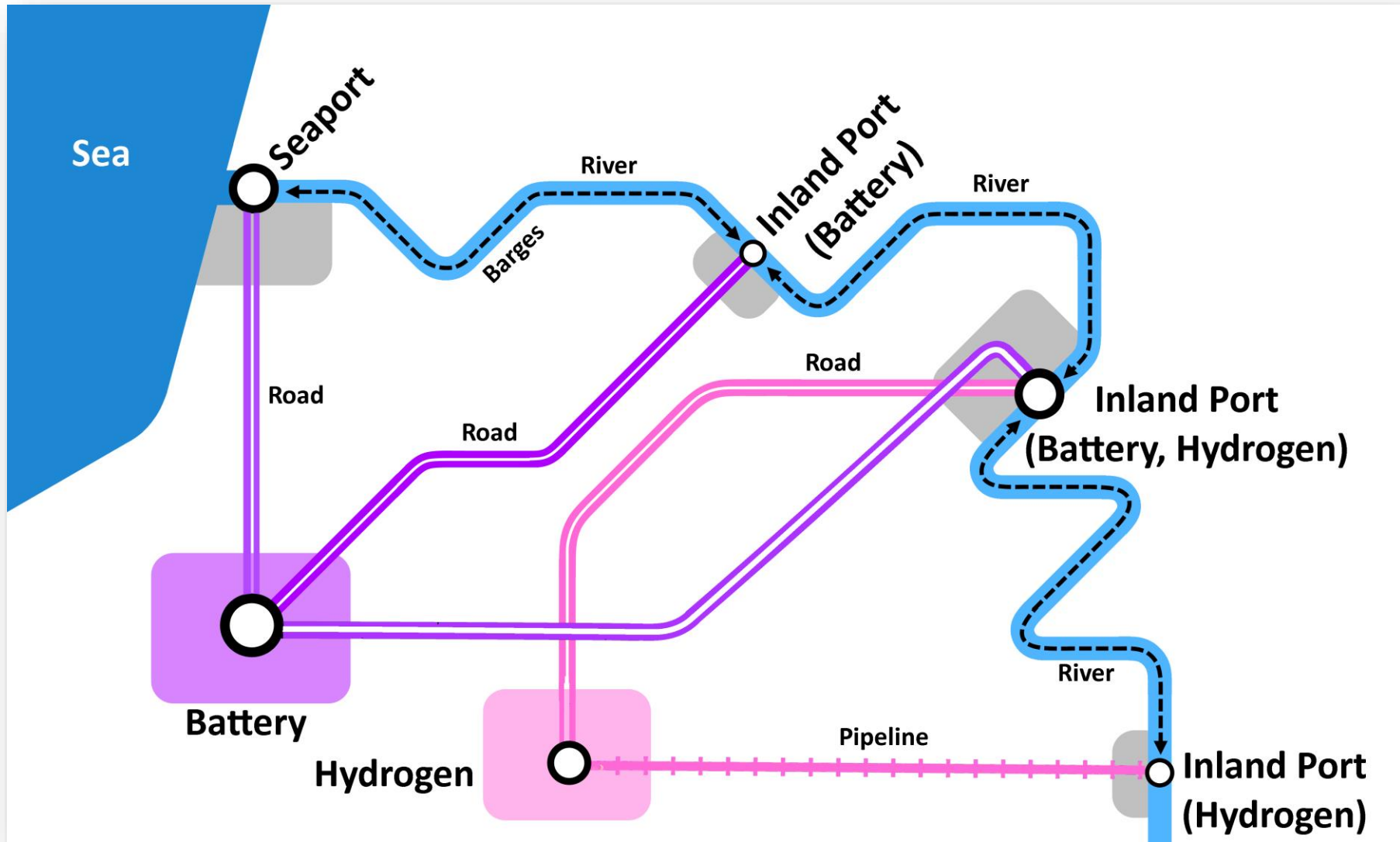


Research Questions

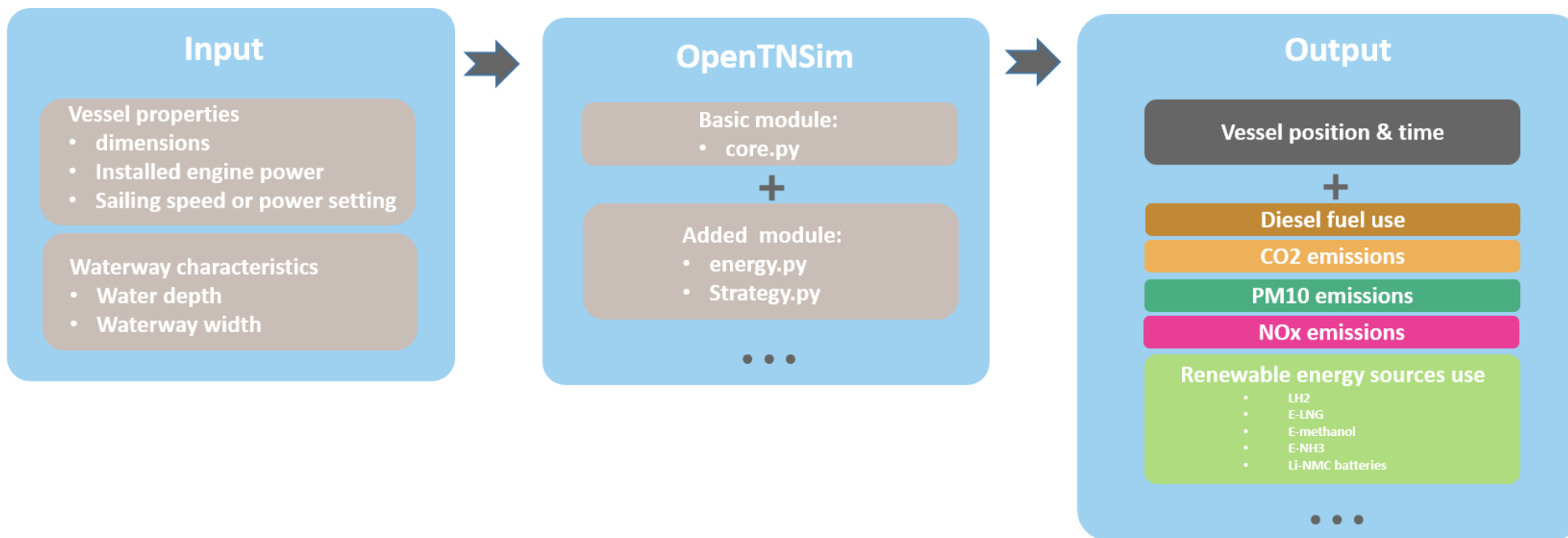
- What is the impact of **hydrodynamic characteristics** of water, vessel properties, and vessel operations in the corridor on vessel fuel consumption, maximum driving range, and emission rates?
- How to determine whether the **available** bunkering infrastructure is sufficient for future demand?
- How can the **robustness** of the designed bunkering network be captured, and what factors impact this design?

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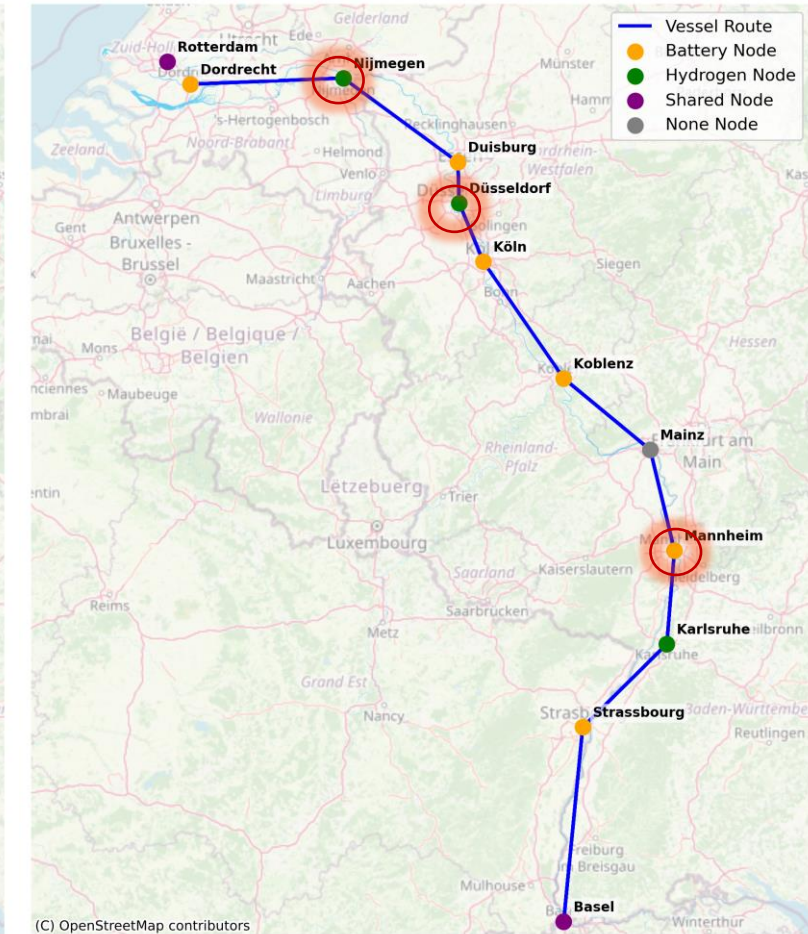
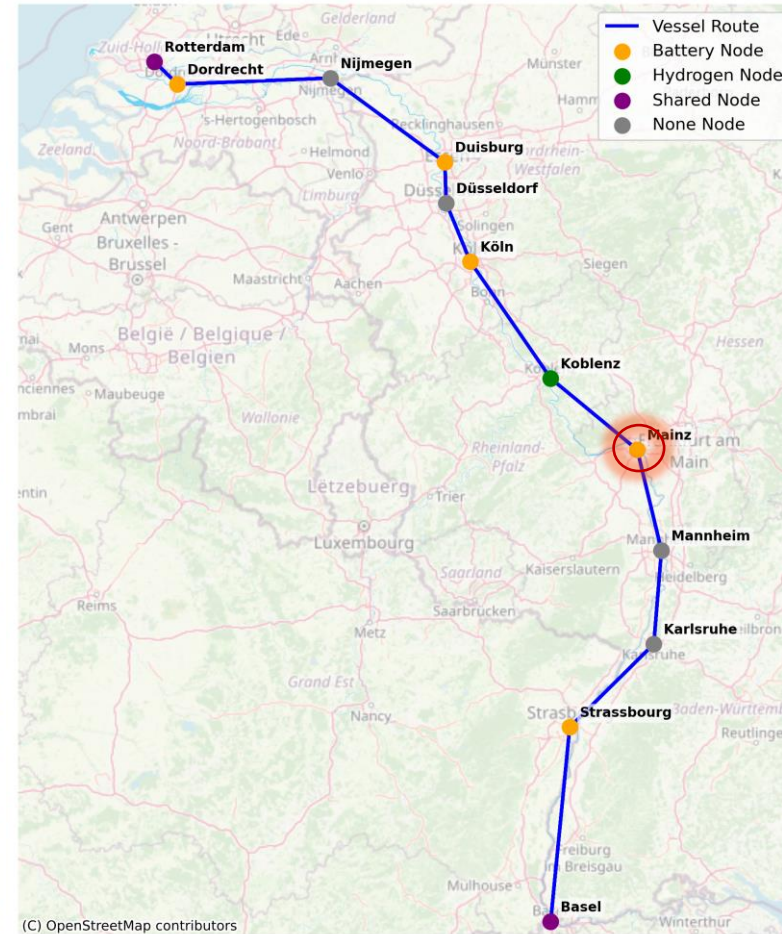
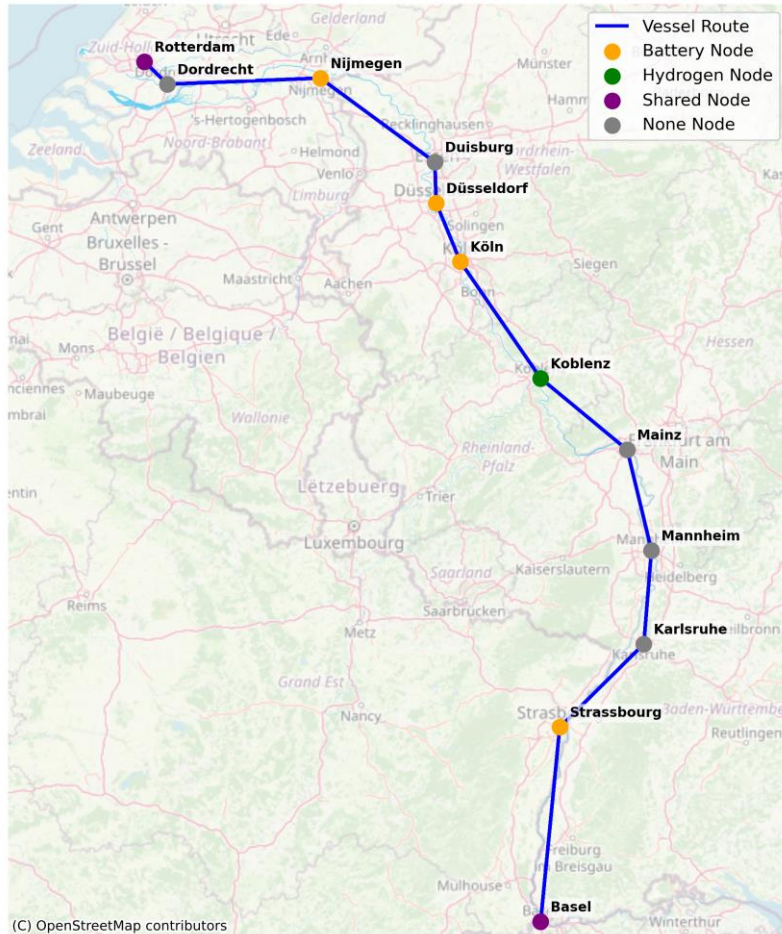
Research Progress



Length of vessel: 135 m
 Beam of vessel: 11.45 m
 Draft: 2.75 m
 Fuel types: battery, Hydrogen



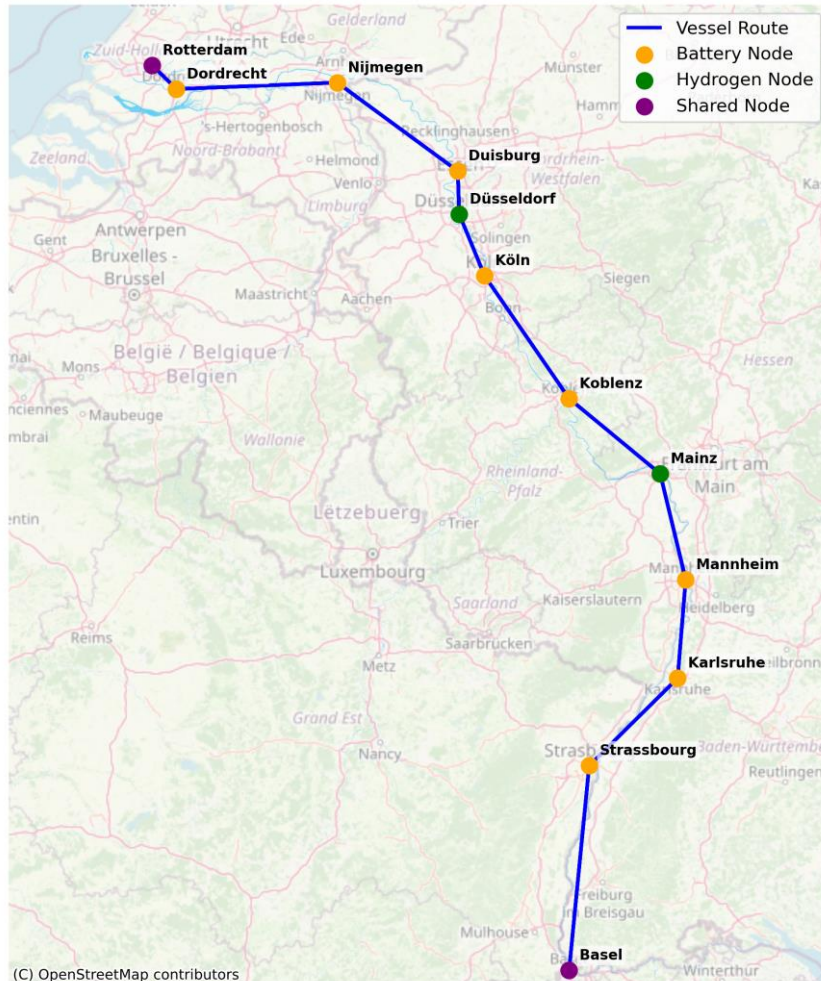
		Space	Time	Engine types	Multi-dimensional quantification of fuel use and emissions in inland shipping		
Individuals	Individual vessels of various types	g / m	g / s	Internal combustion engine (year)	Transport volume	upstream trip	Corridors
		g / km	m ³ / s	PEMFC fuel cell engine			
		kg / km	liters / hour	SOFC fuel cell engine	m ³ / ton-km	round trip	
		m ³ / km	ton / year	Battery- electric propulsion			



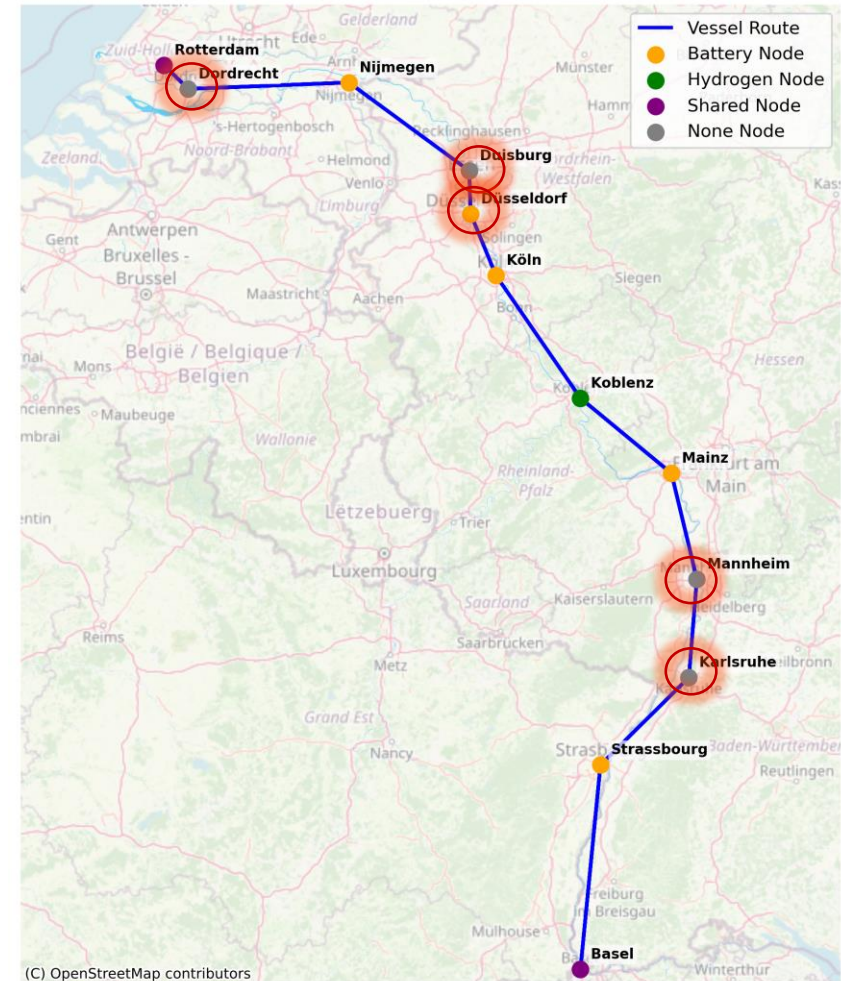
battery vessel speed = 10 km/h
hydrogen vessel speed = 13 km/h

battery vessel speed = 12 km/h
hydrogen vessel speed = 16 km/h

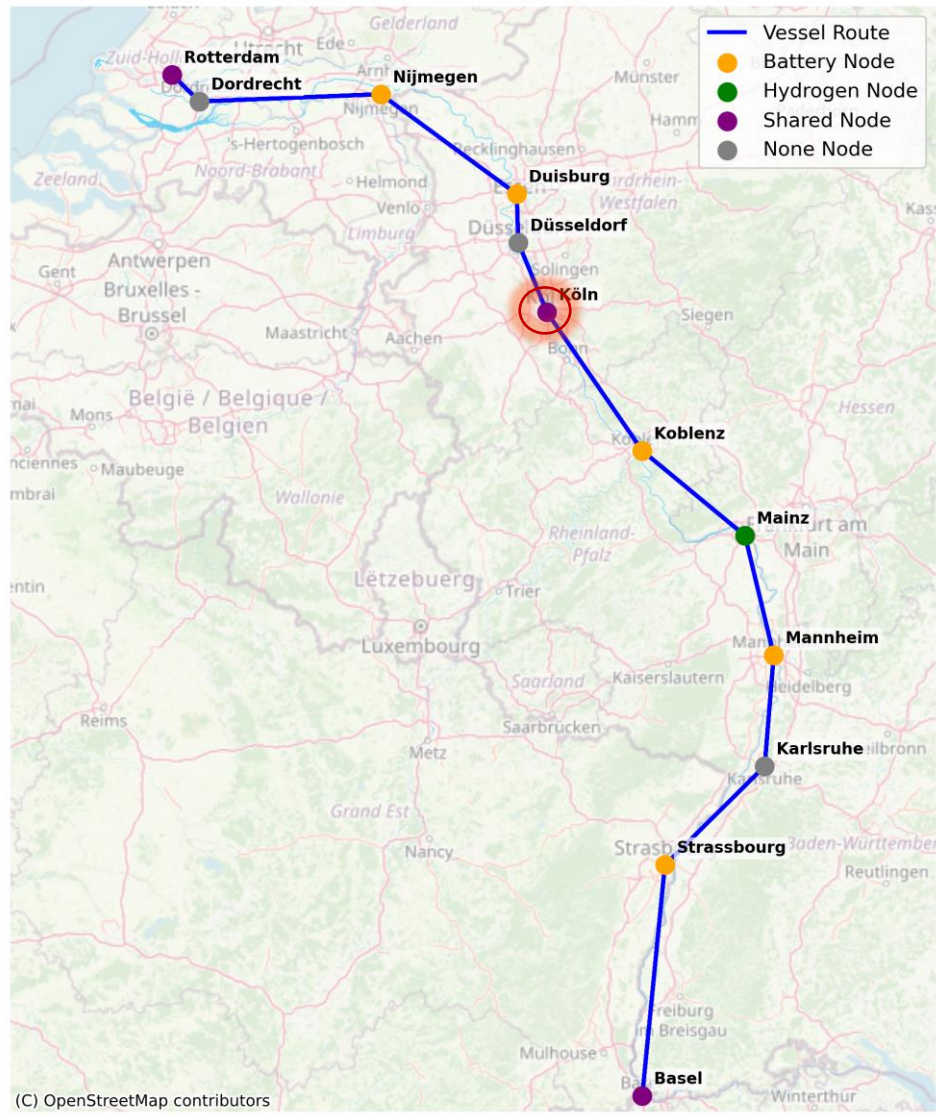
battery vessel speed = 13 km/h
hydrogen vessel speed = 20 km/h



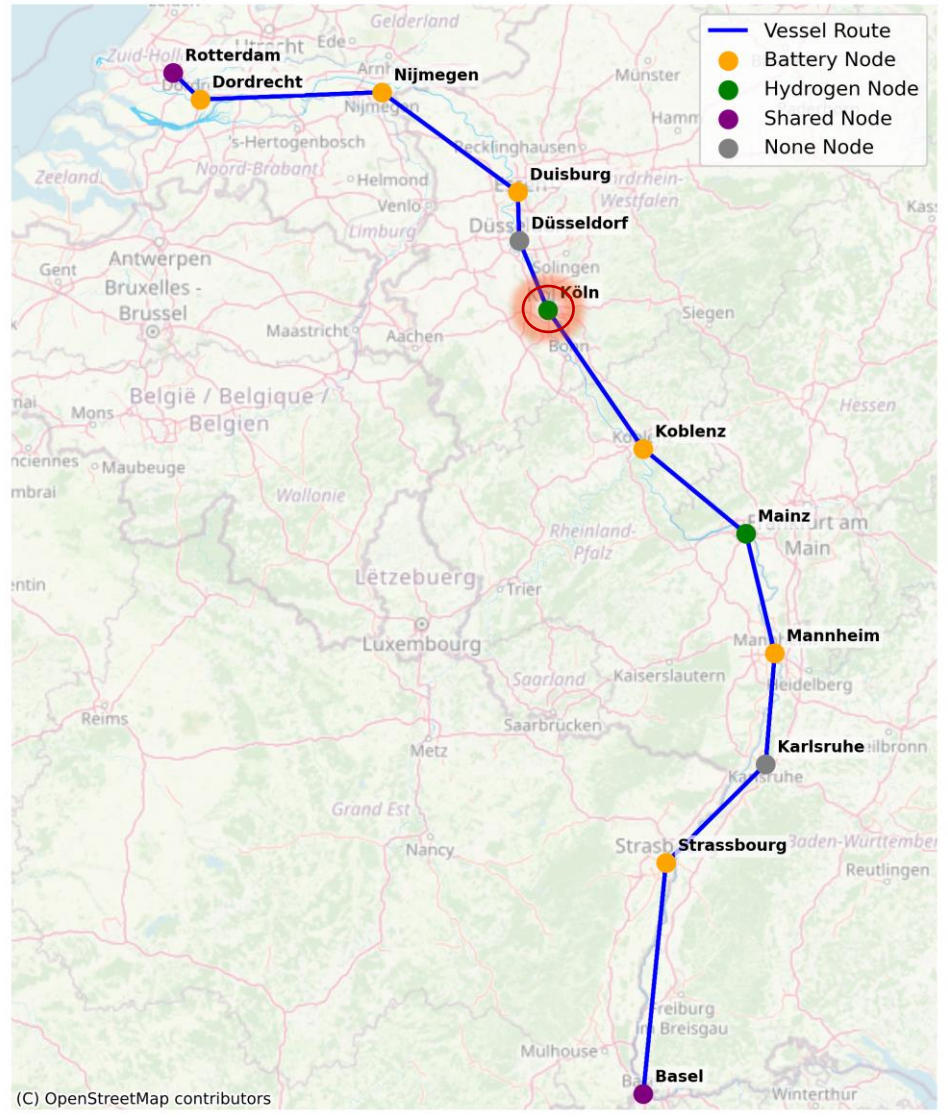
battery capacity = 1000 kWh
hydrogen capacity = 500 kg



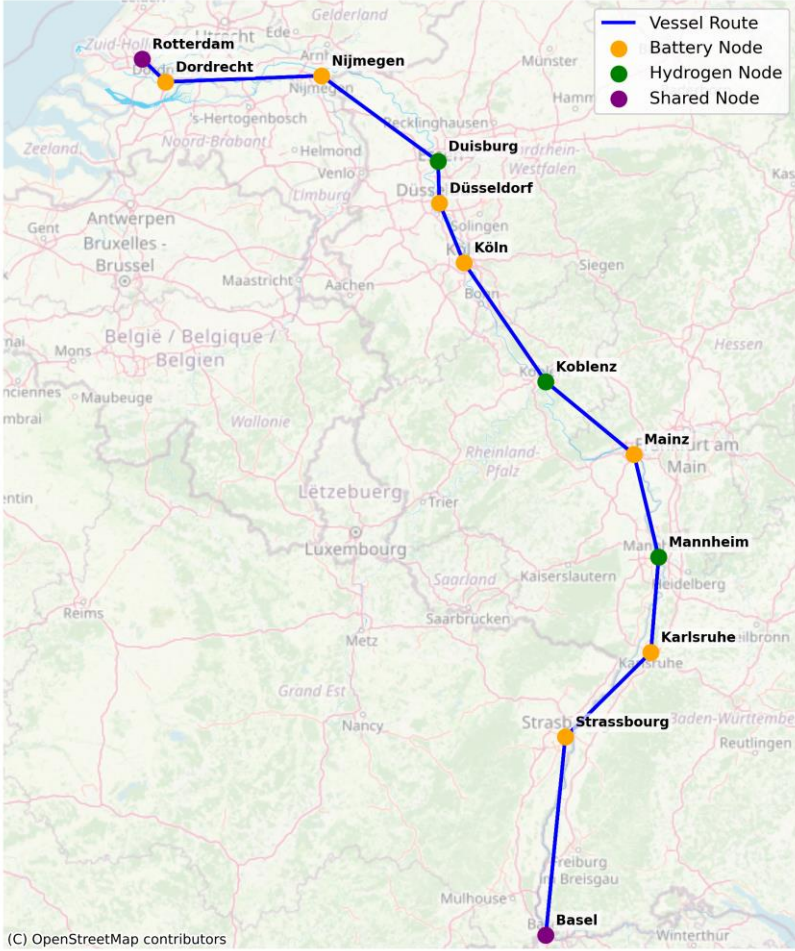
battery capacity = 2000 kWh
hydrogen capacity = 750 kg



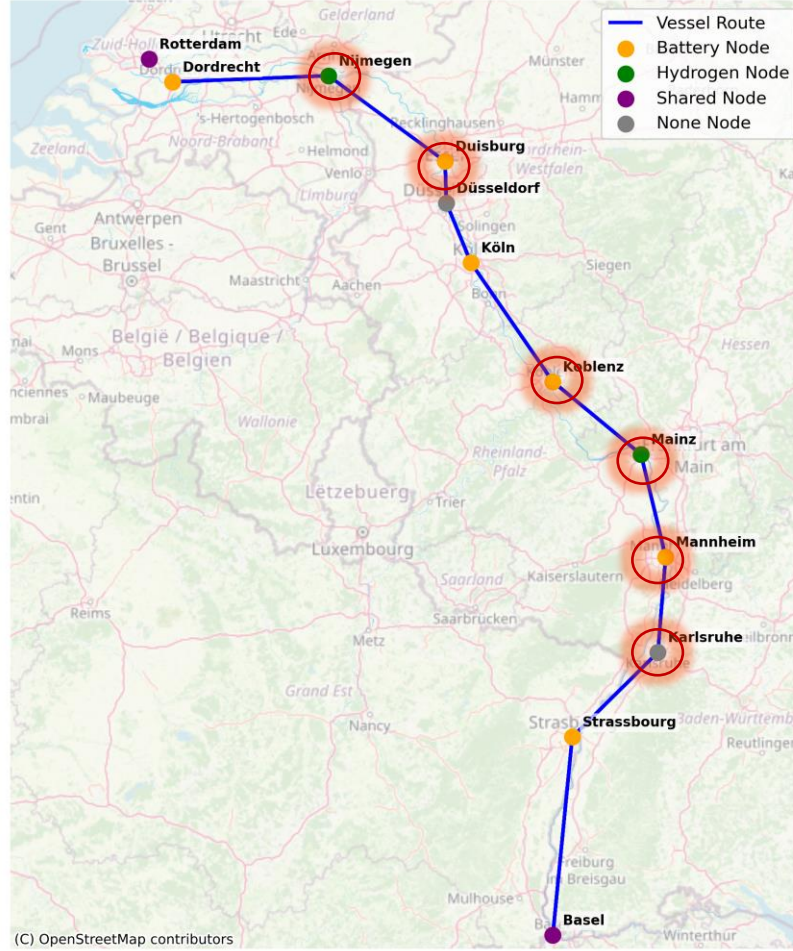
Multiple fuel types



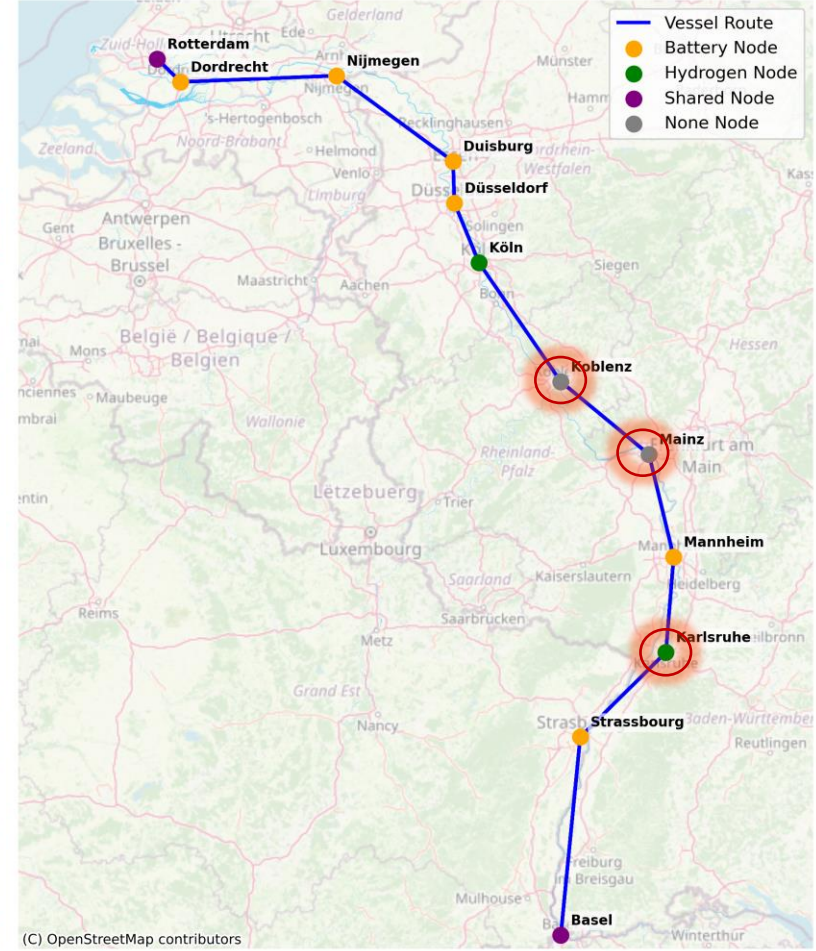
Only one fuel type per station



Waterways depth = 3.5 m



Waterways depth = 5 m



Waterways depth = 9 m

03

Next Steps

- Presence of fuel suppliers (linking supply sources with demand locations)
- Different corridors, including the presence of locks,...
- Detailed characterization of waterways (depth profiles, width variations, and speed limits,...)
- Different bunkering types including fixed stations, truck-to-ship, pipelines,...
- Fleet diversity and boundary conditions including varying vessel sizes,...



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**Thank you for
your attention**