

Rotterdam CO2 Cluster Development

Ernest Groensmit

Senior Advisor Business Development

the Netherlands Organisation for
applied scientific research TNO

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Rotterdam CO2 Cluster Development

- The Current Situation
- Concepts for Capturing
- Concepts for Storage
- Local Impacts
- Other Regions
- Future Situation

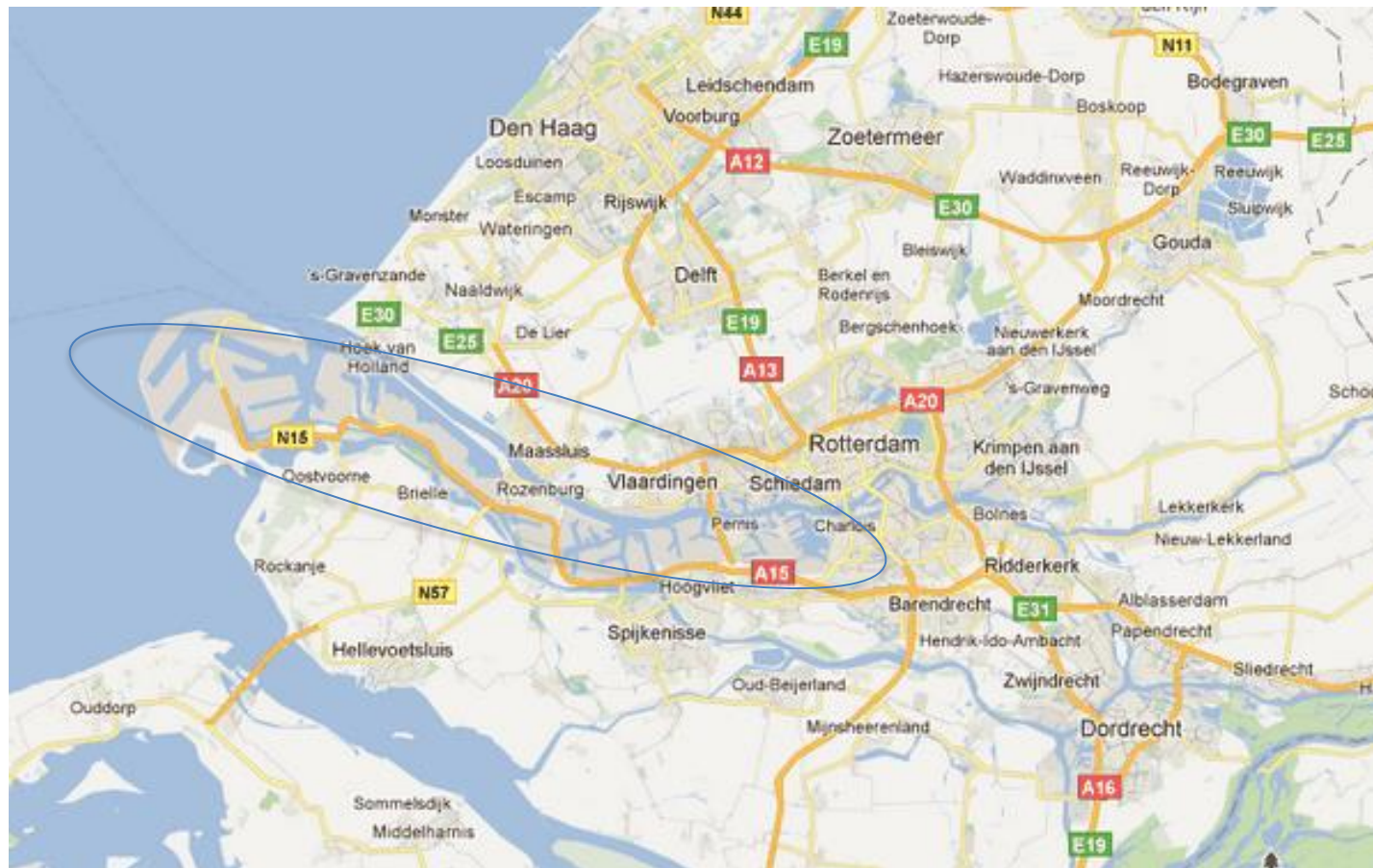
Considerations

- Concept valid for Transition Period 2020 -2050;
- Utilizing existing industrial assets to the maximum extend while directly reducing CO2 emissions;
- Providing solid basis for CCUS in Rotterdam Area;
- Allowing reduction of CO2 emissions from household sector;
- Allowing New Chemistry to develop;
- Allowing reduction of emissions from transport sector;
- Potentially capturing CO2 from air.

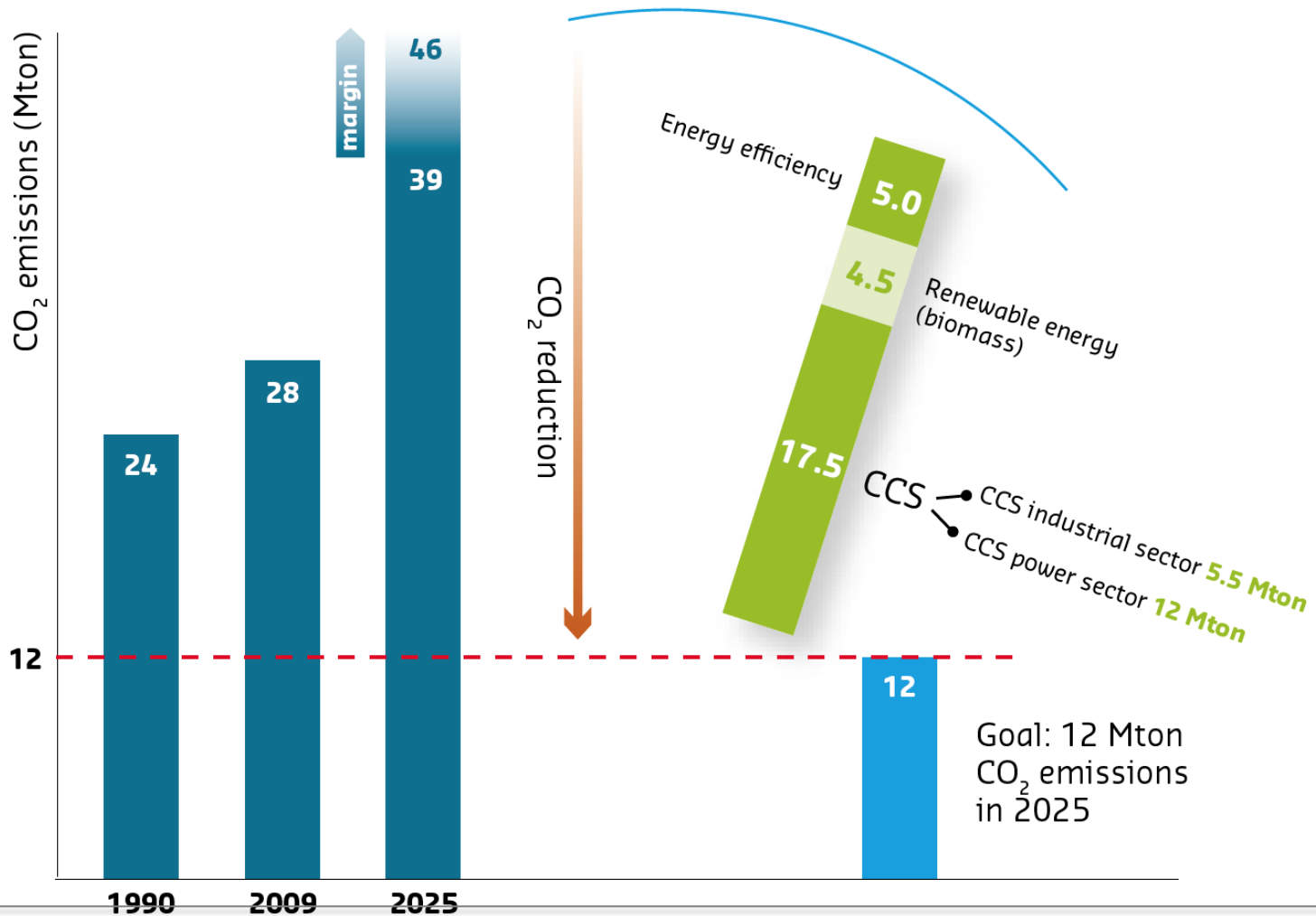
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Rotterdam Industrial Cluster



Rotterdam Region CO2 Emissions



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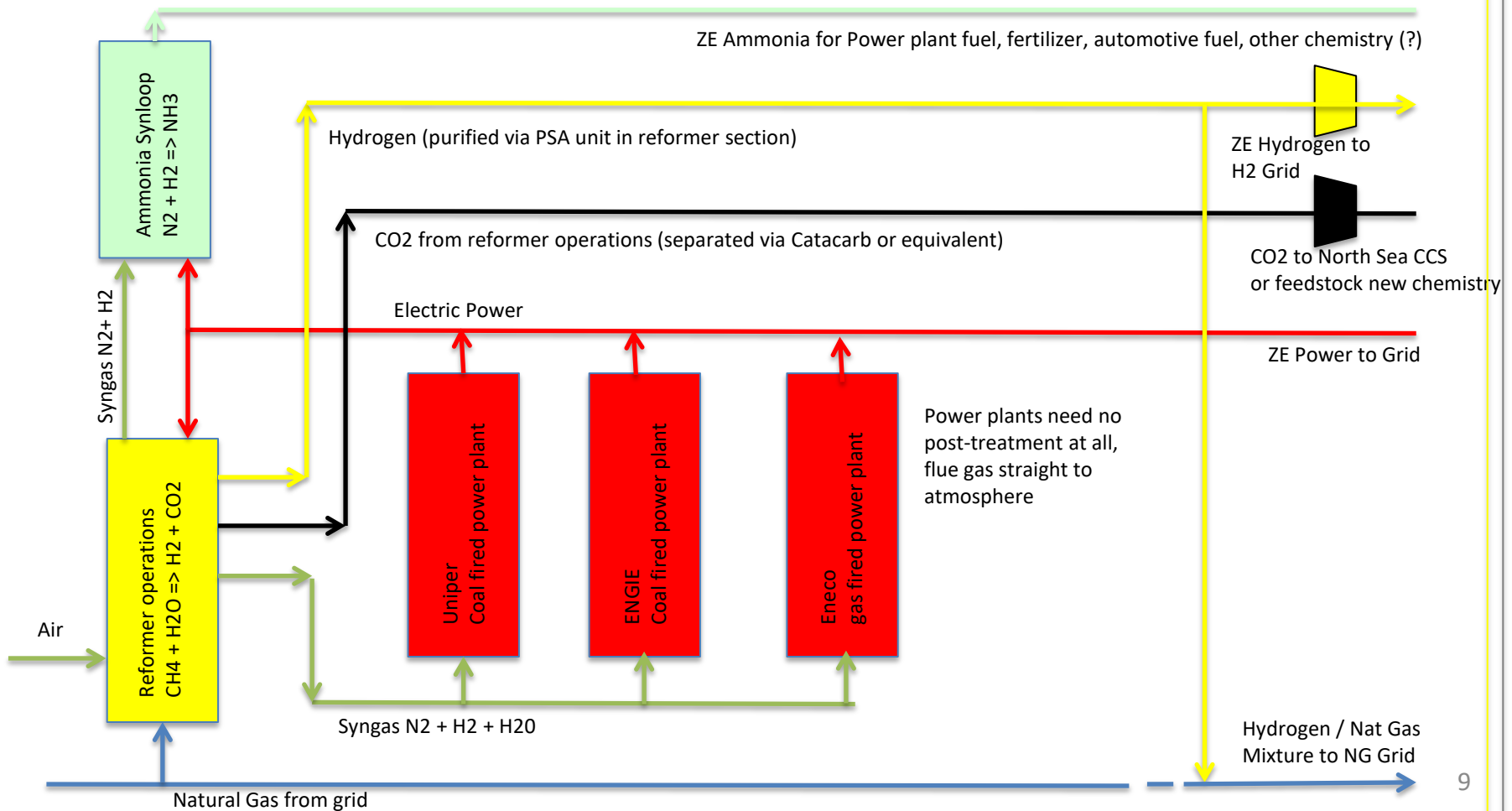
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Concepts for CO2 Capturing

1. Post-Combustion CO2 capturing from CO2 generators in the Rotterdam Region:
 - + CO2 to offshore storage / re-utilization
 - (ROAD is example of this concept)
2. Oxy-fuel firing in coal and gas power plants at the Maasvlakte:
 - + CO2 capturing with offshore storage / re-utilisation
3. De-Carbonize natural gas and use this in any downstream energy requiring process:
 - + CO2 to offshore storage or re-utilization

Natural Gas De-carbonisation

DECA gas processing scheme at the Maasvlakte with minimal impact on existing facilities and substantial potential for new Zero Emission processes



Rotterdam DECA Plant and CO2 Hub

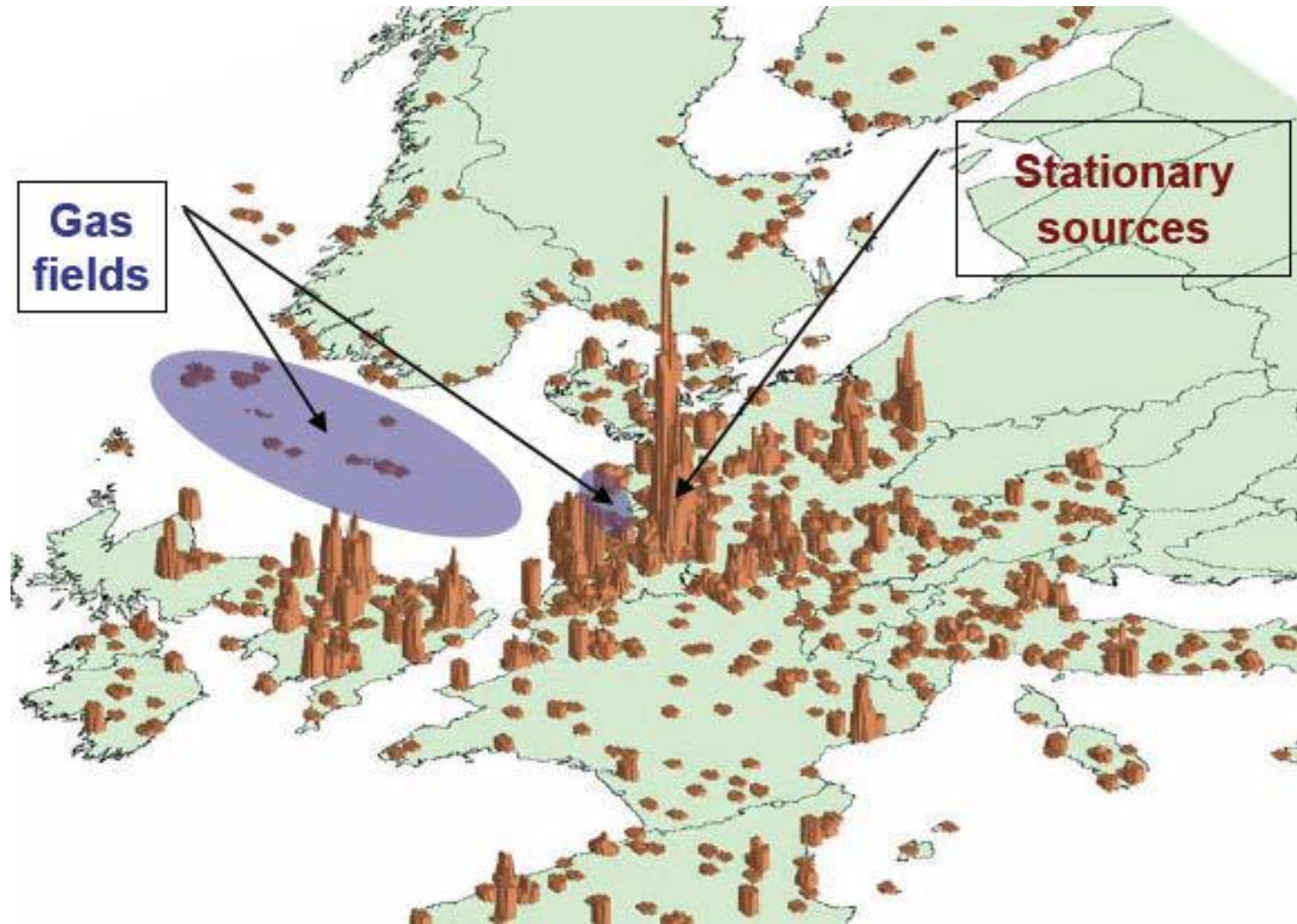
A solid multi-source CO2 collection system will develop with minimal new infrastructure, creating the right economy of scale for re-utilization of CO2 or offshore storage .



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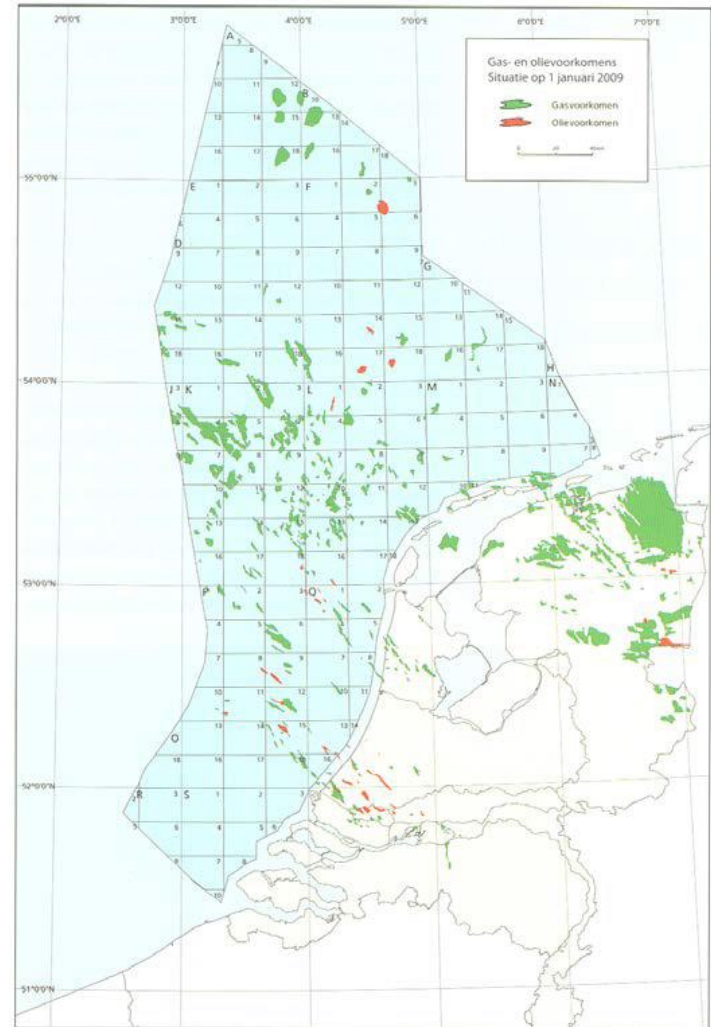
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Offshore Storage Opportunities

1. More than enough storage capacity to serve Rotterdam needs during the Transition Period and many other regions as well;
2. Dutch mining law recently adjusted, now allowing CO2 storage in depleted fields;
3. TAQA has a storage permit granted already;
4. Many E&P facilities at North Sea can be re-utilized for CO2 storage services like pipelines, platforms, service industry, etc.;
5. Start concept with nearby P18 fields, requiring minimal investments for transport.



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Estimated Local Consequences

1. Up to 4 BCM/y of NG can be decarbonized;
2. Between 10 and 15 Mton CO₂ can be reduced from Dutch annual CO₂ emissions;
3. Between 8 and 10 Mton CO₂ captured and stored annually;
4. 2000 – 2500 MW of ZE power generated
5. Hydrogen blending in the NG grid between 0,5 – 2,0 % possible, reducing CO₂ emissions from Dutch households;
6. Substantial volumes of ZE hydrogen and/or ZE ammonia become available for automotive application (fuel cells in EV's) or for use in chemical and refinery processing;
7. Depending on the success of ROAD and a decision to use biomass in the Uniper plant, **extra CO₂ out of the air** can be removed.

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Rotterdam CO2 Hub



Scaling up will be a challenge on its own!

Connecting other Regions

1. Pipelines typically have long lead times due to permitting issues, but once there, can handle large volumes at low cost per ton CO₂;
2. Barges are relatively fast to implement, can still handle substantial volumes and are flexible in destinations;
3. Sea-going vessels can pick up CO₂ from smaller coastal industrial regions (Le Havre and others) through a milk round and deliver it either in CO₂ Hub or directly in offshore storage.



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Future Situation

